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THE

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WIRING RULES.

THE Verband Deutscher Electrotechniker has gone to some pains in the attempt to compile perfectly satisfactory rules by which interior wiring should be governed. These rules are interesting in one or two particulars, as they indicate the gradual change in opinion towards some of the recognised standard methods of putting up wiring work that is taking place. At the same time they must, we think, fail to rouse much enthusiasm in English minds, as they appear to alter certain of the figures given in the Phœnix Rules without good or sufficient reason. The size of fuse to be used is to be settled by the cross-sectional area of the wire in whose circuit it is to be placed; this is good and proper, because the heating that may take place, and the object of the fuse being to prevent undue heating, is inversely proportional to the area. The fuse and wire naturally go together, and if, say, half a dozen sizes of wire be all that are necessary (as can easily be arranged), then the fuses may have terminals suited for one size of cable and for that only.

The most questionable departure, to our mind, is the figure to which the minimum permissible insulation has been reduced. The German rules require only an insulation resistance represented by 1 megohm per lamp, instead of the 25 megohms specified by the Phœnix Office for alternating, and the 12½ megohms for continuous current work. To minimise the evils likely to result from this laxity, a constant factor of 10,000 ohms is added to the variable, taking into account the number of lamps. There seems to be no real need of any reduction in a figure that is easily met by doing good work. Most of our supply concerns require a much higher value than that given by the Phœnix Rules, and as we pointed out in a recent article on the Board of Trade Conference, the forthcoming regulations will probably include a clause indicating 75 or 100 megohms per lamp as being the insulation required in order to obtain a supply from street mains. "Good wine needs no bush," and good wiring work no excuses. Besides, we know instances of 30 lamps testing out at 30 megohms, or 900 megohms per lamp, and of 60 lamps at four megohms; even 250 lamps, carefully wired, have given 3½ megohms. The new German rules are precise in two particulars, that the insulation resistance shall be calculated from a reading taken after one minute electrification, and that the test shall be made with the working pressure, and preferably with the negative pole of test battery to line.

This is a step in the right direction. Our readers are already aware that wood-casing work is prohibited by the new rules, but that porcelain insulators, cleats or tubes may be used. From a knowledge of what is being done with interior conduits, we look for a more careful and logical consideration of the insulating tube system, and less prejudice being shown when dealing with this method of

running and protecting conductors. Evidently English engineers, as a body, have neither investigated nor carefully thought over the methods by which interior work may be done, otherwise than by wood casing—too often made the excuse for slipshod, slovenly jointing and running—or the discussion last week at the Institution of Electrical Engineers would not have been as feeble as it actually was. The death-blow to the Peschel, one of the visible wiring systems, is given by the statement in the revised rules that flexible conductors "must not be fixed permanently along ceilings or walls." This importation from Germany has never taken a hold in England, and now we find that in its country of birth it is stigmatised as unsafe by being included in the undesirables.

The Incandescent Lamp in Gunnery Experiments.

Amongst gunnery experts there are few questions, perhaps, around which controversy is so frequently rife as those which relate to the relative movements of fire-arm and projectile during the very short periods in which they exercise their respective functions. In such matters theory is apt to outstrip exact knowledge, because the former is about as easy to propound as the latter is difficult. Happily, however, the obscurity of these engineering bye-ways is being rapidly cleared up by a judicious combination of those two comparatively new branches of science, photography and electricity. These same two branches are affording valuable information respecting the velocity of projectiles, and consequently of the relative value of different guns and different powders. Some of the methods adopted have been explained in these pages during the past year. Recently, Prof. Albert C. Crehore and Lieut. George O. Squier, of the United States, have been investigating the subject of recoil. These methods may be explained by reference to the well known moving wheel, so familiar in optical experiments, it being understood that a record is required of the path traced by a single luminous point on its circumference. An ordinary camera is placed at any convenient distance from the wheel perpendicular to its plane, and a sharp focus is obtained; then to some point upon its circumference is attached a small incandescent lamp. The conditions of working are those of darkness. The *modus operandi* is first to expose the camera; then roll the wheel carrying the lamp across the field of view; then close the shutter. Upon developing the plate it is found that the image of the lamp has described a miniature cycloid—an exact reproduction of the path described by the luminous point on the wheel, and reduced in the ratio of the size of image to object. Working on these principles, the experimenters succeeded in obtaining a series of curves from which, by mathematical analysis, they were able to obtain the desired information respecting the recoil of the gun. Their work and results are fully described in *Arms and Explosives* for January, pp. 55—57.

Some Hints to Investigators of Spark Spectra.

At the present time, when attention is keenly directed to the subject of spark spectra, it may be desirable, for such as are interested, to study a recent paper by A. de Gramont on the direct spectrum analysis of minerals and fused salts (*vide Comptes Rendus*, cxxi., pp. 121—123). Many of the minerals have sufficient conductivity or volatility to permit the passage of a condensed electric spark between the small fragments of the mineral attached to the pole of the coil. With a condensed spark the spectrum shows the lines both of the metals and of the non-metals present in the mineral; without the condenser, the spectra of the non-metals disappear, and those of the metals show only the brightest lines. Certain fused salts behave in a similar way, and when the condensed spark is used, the spectrum contains the lines of all the elements present, together with some air lines, which, however, are much enfeebled, especially if the striking distance is short. Without the condenser, the spectra are complex, and characteristic of each particular salt. De Gramont suggests that such spectra are probably produced by undissociated molecules. The condensed spark gives the best results in the case of minerals; but in the case of salts, the spark without a condenser often gives valuable indications.

The Experimental Proof of Certain Generalisations.

In a recent issue of the *Chemical News*, Vol. lxxii, p. 273, there is a paper by Dr. Meyer Wildermann on the experimental proof of certain generalisations which, for the last few years, have been absorbing the interest of those who are investigating the "borderland" between physics and chemistry. He claims to have experimentally (as many others, indeed, have done before him), the truth of Van't Hoff's constant, Arrhenius's generalisation, the law of dilution, and Dalton's law in solutions; and he has also thrown some new light upon the degree of dissociation in solutions when non-electrolytes are present; and on the reduction of the degree of dissociation by introducing a common ion. The methods adopted in the latter investigation were similar to those of Arrhenius, who employed the method of freezing points, and that of electrical conductivity. Dr. Wildermann found no considerable reduction of the degree of dissociation when non-electrolytes are present, and he attributes the diminution of the electric conductivity, which he observed, when there is a non-electrolyte in the presence of a dissolved electrolyte, to the change of the inherent viscosity. In regard to the reduction of the degree of dissociation by introducing a common ion, a research was conducted by Dr. Ostwald, at Leipsic, also. The result was an ample confirmation of the theory first expounded by Arrhenius in a paper entitled, "Theory of Isohydric Solutions" (*Zeits. Phys. Chem.*, II.). In this research Arrhenius only used the method of electrical conductivity, but Ostwald and Wildermann also used the method of freezing points.

The Toxicity of Acetylene

Some capital is being made out of a statement by L. Brociner (*Comptes Rendus, Hebdomadaires des Séances de l'Academie des Sciences*, cxxi., No. 22) that the toxicity of acetylene, upon which we gave some information a short time ago, is by no means great. Brociner concludes that because animals exposed to the action of gaseous mixtures containing considerable proportions of acetylene did not *succumb*, the toxicity of acetylene must be very feeble. We note, however, that the experimenter was careful to operate in the presence of a considerable quantity of oxygen, and to renew the gaseous mixture so as to prevent the products of the animals' respiration from accumulating. On the whole, these unfortunate animals had a very good chance given them, and we are not surprised that they did not succumb. We are certainly, however, not disposed to place ourselves in accord with Brociner as to the feeble toxicity, since he records no information respecting the state of health of his subjects, merely stating that they did not *succumb*. Any gas which has to be used for illumination, and which, as we have pointed out, must escape into the atmosphere of our rooms, must receive better credentials than that. We certainly require to know something beyond the comforting assurance that we shall not succumb if we breathe it. Our readers will remember the medical evidence which we placed before them concerning the toxic properties of this wonderful gas, and hitherto this evidence has not been contradicted. Brociner proves nothing that a gas consumer can take the least possible interest in. What the latter wants to be assured of is, that acetylene is in no way injurious to health. And he will want in vain.

ELECTROMETALLURGY IN 1895.

By E. ANDREOLI.

The progress accomplished during 1895 in the applications of electrolysis to metallurgy is extremely encouraging, and promises a commercial development which, a few years ago, many electricians would have been very cautious in predicting.

It is regrettable, however, to have to record that in Italy the works at Casarza, where the Marchese system was worked for several years, have not yet been reopened. But, from what we have been told, financial difficulties are the only reason for the stoppage. No doubt work will be soon resumed there.

In Australia, at Broken Hill, where an almost inexhaustible mass of argentiferous blende exists, which is much more rebellious to treatment than the copper ores of Casarza, two bold attempts have been recently made to recover, by electrolysis, the metals contained in this ore.

Messrs. Siemens have made experiments on a large scale in Berlin for the electrolytic recovery of metallic zinc from the Broken Hill sulphides, and they have been so successful that the Smelting Company of Australia has been formed in this country with a capital of £500,000 sterling, to erect in Illawarra smelting works similar to the plant at Berlin, but much larger, where the ores will be treated by smelting, and subsequently electrolysed. Then the zinc, lead, and silver will be refined at the same time as oxide of zinc will be produced.

These Broken Hill ores are of a very complex nature, and consist mainly of zinc, lead, silver, copper, sulphur and iron, and owing to their particularly strong combination, it has been up to the present an impossibility to separate their metals profitably.

In order to unlock the silver from the blende in an efficient and simple manner, the zinc must be thoroughly, or almost thoroughly, eliminated, and attempts have been made to effect the removal of this undesirable metal by means of a solvent, which converts the zinc into a soluble salt while the silver and other constituents of the ore remain unaffected. It would be superfluous to enumerate the mechanical, chemical and metallurgical operations through which these sulphides, or similar sulphides have had to pass during the last 20 or 30 years at the hands of the most competent men in this country and abroad; it will suffice to briefly state that the ores must be crushed, roasted, concentrated, leached with solvents; and without description or comments on the Marsh and Storer process, adopted by Messrs. Siemens, we shall admit as a fact, that Messrs. Siemens have reached safely the point where they have only to separate metallic zinc and silver from a solution which flows through a series of electrolytic vats.

It is generally known that some metallurgists have, by lixiviation of the Broken Hill blende, formed solutions of chlorides, of oxides or of nitrates. Others have converted the sulphides into sulphates. The electric current has, however, disappointed many of them when applied to recover the metals by electro-deposition, and for one reason or the other, the metals precipitated were too impure, or the solution was not exhausted, or the process was found to be too expensive. At Leadville, where electricity was applied to a chlorination process, part of the zinc was deposited on the cathodes, and there was, as a residue, a free smelting ore.

Letrange electrolysed a sulphate solution with a copper anode; Cassel and Kjellin used also a zinc sulphate solution. Their anode was of iron, their cathode of zinc, and a porous partition was used. However good may have been the results of their experiments, the porous cells are not practicable, and condemned the whole process.

Commercial electrolysis in mining districts is rendered prohibitive if porous diaphragms are wanted; they break, are saturated with salts of all sorts, and after a certain time are no longer reliable. Messrs. Siemens's process is simple and effective; it consists in sulphatising the ores and electrolysing a sulphate of zinc. According to Messrs. Siemens, spongy and not metallic zinc is deposited on the cathode when the zinc sulphate solution is alkaline, and contains impurities; they also have ascertained that if the electrolyte circulates at a very high speed, by means, for instance, of a stirring apparatus, and by forcing compressed air into the lye at the lower end of the vats, a solid deposit of zinc is obtained. This does not surprise us; it somewhat resembles the Tommasi method, which consists in revolving the cathodes which are not entirely immersed in the solution, and thus are submitted to the oxidising action of the air. The more rapidly his cathodes are revolved, the finer and harder the grain of the deposit metal.

In the Siemens electrolyser the anodes are made of lead, which peroxidises; the cathodes are made of zinc. The electrodes are separated by wooden partitions, and are immersed in the tanks, so as to leave a space between the top of the lye and the bottom of the tanks, while air pipes are fixed at the bottom of the compartments. The electrolyte consists of oxide of zinc, dissolved by sulphuric acid, so as to have a zinc sulphate solution of about 10° B., and an acidulation of 5 to 10 grammes of acid per litre. The anodes are 1 metre long and 0·7 wide. The velocity of compressed air represents a volume of 1·3 cubic metre per hour.

The electric current is about 50 amperes per square metre of cathode. Nothing can be simpler than this arrangement, which is evidently extremely practical; the only thing we do not know is the E.M.F. It is probable, however, that with a rapid circulation and pressure of air, the electrolytic operation takes place in quite an easy and inexpensive manner.

Great confidence is also held in some quarters in the treatment which Mr. E. N. Ashcroft intends to apply to these zinc bearing refractory ores of Broken Hill, the special features of which are, that he first oxidises the ores, then leaches with ferric sulphate, and electrolyses the zinc sulphate solution from which all the iron has been precipitated.

When his neutral solution contains sulphate of silver, the silver is recovered by zinc or lime, soda, or magnesia, and the solution is subjected to a double electrolytic process, whereby a portion of the zinc, equivalent to that dissolved from the ore, is recovered in the metallic form, and an amount of iron sufficient to take up the free acid and oxygen, set free from the zinc, is first dissolved in the solution in the state of ferrous sulphate, and afterwards raised to the form of ferric sulphate. Mr. Ashcroft arranges his vats in sets of three; in two of them he has *soluble* iron anodes, while in the third he has what he calls *insoluble* carbon anodes. Is carbon really to last long as an anode in a sulphate solution?

In the description of his method, Mr. Ashcroft insists in pointing out that his vats are connected in series, and underlines the following words—*whereby each vat is traversed by the same current.*

In the two first vats, the iron anodes are separated by porous diaphragms, such as textured cloth, prepared asbestos or parchment paper. This is not a good arrangement.

These diaphragms, together with the anodes and cathodes, do not extend to the bottom of the vat. Is this a circulation which secures the passage of all the liquid mass between the negative and positive electrodes? Mr. Ashcroft thinks that the neutral sulphate of zinc solution, free from iron, which is poured into the top of the negative compartments, when it passes down the vats and up the anode, is continuously drawn off at the top of the latter. *Prima facie*, it does not seem so. The solution descending past the cathodes is depleted of a portion of its zinc, and that ascending past the anodes is charged with a certain amount of ferrous sulphate. In the third tank, carbon anodes and diaphragms, extending to the bottom of the tank, are used. Where is the difference between a circulation with porous diaphragms which do not reach the bottom of the vat and the one with porous diaphragms which touch it? The solution of zinc containing ferrous sulphate, which comes from the two previously described vats, circulates past the anodes in this third vat, while fresh neutral sulphate of zinc solution, free from iron, is circulated in a separate current past the anodes.

We do not say that this electrolytic process does not effect the deposition of zinc, but it certainly lacks simplicity, and it would be interesting to have some data as to the results of the electrolysis of a few tons of sulphate of zinc solution, *i.e.*, the yield of zinc and its cost, as well as the percentage of zinc left behind in the solution. The Ashcroft process is certainly workable, and, to a certain extent, may be applied to the treatment of the Broken Hill blende, but the superiority

of the Siemens over the Ashcroft system is indisputable from a technical as well as from a commercial and economical point of view.

We cannot enter into the details of the process adopted by Dr. Tommasi for the electrolytic extraction of lead, copper, zinc, &c., from their ores, but we must look on it as a striking illustration of the combination of the knowledge of chemistry and electro-chemistry. We will merely state here that the cost of extracting, separating, and refining metals by the Tommasi method is considerably lowered by preventing the polarisation of the cathodes, by reducing to a minimum the resistance of the electrolyte, by keeping the electrolyte homogeneous, and by separating the metals from a binary or ternary compound with the combined aid of electro-deposition and of chemical precipitation.

We need not speak of the electric manufacture of aluminium. The extraction of this once rare metal is, in the fullest sense of the expression, an absolute *fait accompli*. The electric furnace will, no doubt, make other wonders.

What has become of the magicians who not long ago made such sensational statements about the production of aluminium—some at 6d., some at 3d. per lb. The world is such that a man who has an honest process, with a chance of a modest but certain profit, will in many cases not be listened to. Let him offer extraordinary results; people will rush at him, and, of course, burn their fingers. *Vulgus vult decipi.*

Since 1883, we hear of the Molloy hydrogen amalgam, which amalgamates splendidly sulphides and other rebellious auriferous ores.

We shall not here discuss the efficiency of the process—it is not worth dealing with; but after 13 years, it seems as if the time had come to say a few words on this so-called hydrogen amalgam, a pleasant, elegant, and seductive expression, which has, perhaps, been invented by Mr. Molloy, but which scarcely exists as a product of his apparatus. It is a great mistake to suppose, and it is not admissible that the occlusion of hydrogen in a mercurial cathode forms an hydrogen amalgam. On the contrary, it does not produce hydrogen amalgam more than ozone passing through water could produce peroxide of hydrogen.

Still, since 1883 all the scientific publications, even the most recent books on gold, contain the illustrated description of the mysterious and genial apparatus of Mr. Molloy, which is supposed to prepare the hydrogen amalgam. How silly we have been! We forgot that Joule, Graham, and many other illustrious men had been working at the problem, and we forgot all about their researches and results, and without further examination we have leniently tolerated the heresy of the preparation of hydrogen amalgam for extracting gold and other precious metals from their ores.

We have not the remotest wish to insinuate that Mr. Molloy does not really believe that he has invented, nay, that he makes true hydrogen amalgam; on the other hand, we think that not only he does not make it, but that he cannot make it, and that he simply makes an ordinary sodium amalgam by electrolysing a soda solution in presence of a mercurial cathode. His last apparatus seemed to be more promising, and was really fascinating. Instead of passing auriferous ores on a mercury cathode which contained a little sodium, he has adapted to the precipitation of gold on his cathodic layer of mercury the well-known method used before by Moissan and others for obtaining metallic amalgams, the difference being that in the Molloy apparatus the gold solution is circulating through a shallow tray containing mercury, in which is an inner cylindrical vessel filled with carbonate of soda, the edges of the cylinder just dipping beneath the mercury, so that its contents are entirely cut off from the other portions of the vessel.

A rod of lead dips into the soda solution; the lead and mercury are connected with the poles of the dynamo, and the solution is electrolysed. The sodium released combines with the mercury to form sodium amalgam which decomposes the gold cyanide solution with formation of gold amalgam, sodium cyanide being simultaneously produced.

This electro-amalgamation is theoretically absolute perfection. In practice the amalgam does not catch the gold so greedily as supposed, unless the circulation is very slow. An enormous quantity of mercury would be necessary for exhausting, say, 100 tons of gold solution per day; it would not be easy to retort such a mass every month to get the gold it contains. The process is not bad, but will not revolutionise the gold industry. At all events, it is far superior to the first Molloy electric hydrogen amalgam, and we hope that once and for all we have done with this mythical substance—hydrogen amalgam.

Gold is rapidly deposited on numerous amalgamated plates suspended in its solutions, where each of them is in contact with the circulating electrolyte, and their surface is considerable. But a layer of mercury as a cathode, even if it is an insolisable hydrogen amalgam, unless its area is very great, does not offer a sufficient active surface for absorbing all the gold of, say, 20,000 gallons of solution per day.

Some electricians have proposed the combination of amalgamated plates between porous cells containing the anodes; but porous diaphragms are a bad contrivance, which by all means must be discarded, and besides, there is no need of diaphragms in the electro-deposition of gold, which takes place readily without them.

We will but briefly mention here the following methods for the electrolytic extraction of gold from its ores or solutions. Pelatan and Clerici use anodes formed of, or coated with iron, steel, or platinum, in a weak cyanide solution, to which chloride of sodium has been added. A layer of mercury is their cathode.

The Electro-Chemical Reduction Company, who work a process in which a mercurial cathode, called without ceremony hydrogenium amalgam, also is used, increase the surface of their cathode by means of small strips of copper, in order to have a more perfect contact with the gold solution. As the solution passes over the mercury, a central compartment containing a special anolyte and anode is moved slowly, longitudinally in the tank, which spreads the mercury, and insures a perfect precipitation.

It is very difficult to go into details on the development of electrometallurgy, because the electricians, as a rule, do not give much information. They cannot, however, be blamed.

We heard last year a great deal about the so-called electrolysis of gold, and although we are unable to speak of practical results derived from the electrolytic extraction of gold from its ores, we are bound to report on this question, which was the cause of so much controversy. Scientists of great fame have condemned the electrolytic extraction of gold from its ores in a most summary manner, and the evidence they gave on the working of the Pielsticker method was decidedly a deadly stroke, which would deter many electro-chemists from attempting to employ the current for recovering gold from its ores in a cyanide of potassium solution. It is very unfortunate that the verbatim reports of the cyanide case have not been published, because from a point of view of real facts, the evidence of the illustrious men who fought so inimically and so stubbornly against Pielsticker, would certainly have raised doubts in the minds of electro-chemists who only know the verdict, but not the arguments *pro* and *con*, the extraction of gold by electrolysis.

The Pielsticker apparatus was not what it ought to have been. Neither carbon nor iron make a good anode in a cyanide solution. It is useless to criticise it; but what may be safely contended is, that electrolysis can recover the gold from a pulverised mass of ore containing it, and that, given two identical samples of auriferous ores in two equal volumes of water, containing each the same quantity of cyanide of potassium, the one which will be treated by electrolysis will show much more gold dissolved than the simple cyanide lixiviation without current.

The electro-deposition of gold is as much important as the process of its dissolution in cyanide of potassium, and we shall not grudge our congratulations to Messrs. Siemens and Halske, who have so successfully started it on a commercial scale, that in the Transvaal alone, at present, about 50,000 tons of gold solution are treated exhaustively by the electric current, and thousands of ounces of gold are deposited every month and recovered in the metallic state. That the Siemens system is inadequate to what is wanted is obvious. We will not insist on its weak points. We must, however, remember that in the Siemens vats, the iron anodes being destructible, the solution is contaminated with impurities, and that the cupelling of the lead cathodes to get the gold which has been deposited on them is a crude, expensive process, which must be rejected in time. The gold electro-

deposition of the future will be based on insoluble anodes, and on cathodes, from which the gold will be directly recovered as metal, and which will be used over and over again.

An eminent metallurgist who died last year, Cosmo Newberry, unlike many of his colleagues, had great confidence in electrolysis applied to the extraction of metals from their ores.

"Electrometallurgy is making very rapid strides, and it seems almost certain that complex ores, such as those occurring at Bethanza, will be treated direct as raw ore for their gold, silver, and copper."

Such was the conclusion of his report in 1892 on the treatment of tailings by the Luhrig system; evidently there was a little exaggeration in the statement of the great Australian metallurgist, but still there is a great deal of truth in it.

THE ABSORPTION OF CATHODE RAYS.*

By P. LENARD.

(*Continued from page* 101.)

It can be seen that the densities and absorptivities form an increasing series, with the exception of irregularities in the case of gases, of nearly equal densities. These irregularities are probably due to the difficulty in obtaining, in each case, exactly the same kind of cathode rays, but they are too great to make certain that gases of the same density have always exactly the same absorptivity.

If the quotient $\frac{g}{M}$ be calculated from the absorptivities and densities for each gas, almost equal numbers are obtained, as will be found in the penultimate column of the table. If the densities are set out as abscissæ and the absorptivities as ordinates, a series of points are obtained which lie very near a straight line passing through the origin (see fig. 1). The relatively greatest deviation is shown by hydrogen gas. I

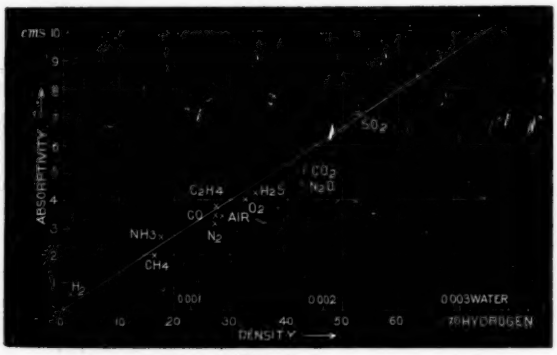


FIG. 1.

have not been able to completely explain this deviation; it appears to be a distinct indication that the absorptivity may be influenced in a subordinate degree by the nature of the medium. Investigations showed that the irregularities were not due to impurities in the gas.

The mean of the three values of the absorptivity for hydrogen gas, 0·473, agrees very well with the value, 0·479 (Table II.), obtained in quite a different way; which again verifies our fundamental assumption.

Experiments were made with ozonised air, but no marked difference was observed in the absorptivity. This was probably due to the fact that the percentage of ozone which can be produced in air by the ordinary methods is always very small.

During these experiments on absorption, arrangements were also made to form a judgment on the turbidity of the medium. For this purpose, an arrangement shown in fig, 2, was added to the phosphorescing screen. The upper part, *o*, *o*, of the screen, serves merely for finding the limiting position, and is covered with aluminium foil, carrying a shadow-throwing cross piece, *s*, *s*. The lower half of the screen, however, serves for the investigation of the turbidity. A semi-cylindrical chamber, K, is fixed on the side of the screen next the window, and is provided with a diametral slit, *σ*, *σ*, 1 mm. in width, through which the rays can pass, and by their spreading out and attenuation on the screen show the disturbing effect of the gas. A few small holes are made in the sides of the chamber for filling it readily with the gas. The distribution of brightness in the image of the slit for different gases, is graphically represented according to the usual plan adopted for the spectrum, in the last column of Table IV. The slit is adjusted 10 mm. from the window, and the screen being 5 mm. further off, is therefore 15 mm. from the window. It is evident that both the absorption and the turbidity of the gas increases with its density, quite independently of the constitution of the gas. This fact was previously established by exhaustive experiments with a small number of gases (H_2, N_2, Air, O_2, CO_2, SO_2) in the ordinary and rarefied condition.

Taking into consideration the results found for the absorption and turbidity of gases, we are able to state that the spreading out of a certain kind of cathode rays in a gas is completely determined in the first approximation by its density; two different gaseous media, which (at the same temperature) are equally dense, show no difference in their behaviour towards cathode rays.

SOLID MEDIA.

5. In the first place I investigated the absorption in aluminium. For this purpose sheets of this metal were inserted between the window and the screen, in the air, when the distance of the screen was again adjusted till the phosphorescent image was just visible. If this distance be *r*, and the distance without the inter-position of the aluminium plate, R, δ the thickness of the plate, then, according to the previous equation, without the metal plate,

$$i = J_o \frac{e^{-l\,R}}{R^2}$$

with the metal plate,

$$i = J_o \frac{e^{-l\,r - a\,\delta}}{r^2}$$

therefore, the absorptivity of the metal

$$a = \frac{1}{\delta}\left[l\,(R - r) + \log \frac{R^2}{r^2}\right]$$

In this way aluminium sheets of very different thicknesses were investigated. In the first place I examined whether it was a matter of indifference, in what position the aluminium plate was placed between the window and the screen. This requirement of the formula was fulfilled; it made no difference whether the aluminium plate was close to the window or close to the screen.

The results of the experiments with different thicknesses of aluminium were recorded in the following table. The thicknesses, δ, are calculated from the weight and surface, taking the density of aluminium as 2·70; the length of the rays, *r* and R, are the means of repeated experiments.

TABLE V.—ALUMINIUM.

Absorbent plate.		Thickness of the same. δ	Length of ray. R.	Length of ray. *r*.	Absorptivity. *a*.	Fraction transmitted $e^{-a\,\delta}$	Length of spark.
		mm.	cm.	cm.	cm^{-1}.		cm.
Medium Aluminium foil (same thickness as the window.)	1 fold	0·00276	6·01	5·30	9,700	$\frac{1}{3\cdot5}$	3·2
	2 „	0·00552	6·37	5·43	6,400	$\frac{1}{35}$	3·4
	3 „	0·01104	7·0	5·0	6,800	$\frac{1}{1820}$	3·2
	4 „	0·02208	6·08	2·45	6,500	$\frac{1}{1550000}$	3·2
Stout Aluminium foil.	1 fold	0·00424	5·50	4·60	8,100	$\frac{1}{31}$	3·1
	2 „	0·00848	5·83	4·17	7,500	$\frac{1}{573}$	2·9
	4 „	0·01696	4·6	2·1	6,000	$\frac{1}{95130}$	2·5
	8 „	0·03392	6·6	1·4	6,200	$\frac{1}{1200000000}$	3·1

One can see from the penultimate column how widely different are the fractions of the radiation transmitted. Notwithstanding this, the values of the absorptivities, *a*, are nearly equal in every case, as was to be expected; thereby giving another proof of the validity of our fundamental assumption. The differences in the values of *a* find sufficient

* *Wied. Ann.*, V. 56, p. 255.

explanation in the difficulty of maintaining the initial intensity of the radiation constant. The least exact results are those obtained with the thinnest plates, due to the small value of $R - r$. It appears to be a matter of indifference how many sheets there were in the absorbent plate; there is not the slightest indication of surface absorption or of reflection at the surfaces of the sheets.

It is to be noticed that all the experiments were not carried out with the same kind of cathode rays, for the rarefaction could not be kept absolutely constant, as may be seen by the lengths of the test sparks in the last column. To the shorter spark lengths correspond cathode rays, which are more absorbed by air (3); the absorptivities found for aluminium appear, on the contrary, to be independent of the spark length, as we find when we arrange them in the order of increasing spark lengths. It follows from this that cathode rays which are more strongly absorbed in air will be, also, more strongly absorbed in aluminium, and, also, very nearly in the same proportion. For our method is essentially a comparison of the absorption in aluminium with that in air. This result justifies *a posteriori* the assigning of the value $l = 3{\cdot}42$ cm^{-1} as the absorptivity of air in the calculations for the tables, and shows that all the values obtained for the absorptivity of aluminium—or their mean value—are to be taken as holding for that kind of cathode rays to which the said absorptivity of air belongs.

We find, therefore, that the absorptivity of aluminium is 7,150 : 3·42 = 2,090 times that of air. The density of aluminium is 2·70 : 0·00123 = 2,200 times that of air. The absorption in aluminium is, therefore, very nearly that which we would expect for any gas of the density of aluminium; that is to say, we find the ratio between density and absorptivity continues, notwithstanding the change in the molecular constitution.

This agreement must be looked upon as something more than accidental if it recurs in a series of a solid bodies. Let us compare, in the first place, some metals with each

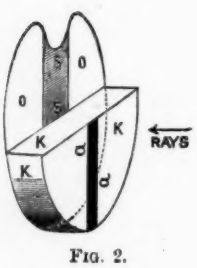


Fig. 2.

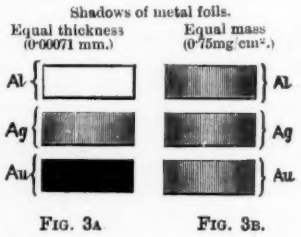


Fig. 3A Fig. 3B.

other. If strips of aluminium, copper, silver and gold foil of equal thickness are placed near each other on the phosphorescent screen and exposed to a beam of cathode rays, on looking at the back of the screen the density of the shadows will be found to increase from the aluminium, which is lightest, to the gold, which is darkest (*cf.* fig. 3*a*; in obtaining these figures a photographic plate was substituted for the phosphorescent screen). In another experiment we shall choose the foil as of equal weight for the same surface, instead of equal thickness. These shadows can now only with difficulty be distinguished from one another (*cf.* fig. 3*b*). Equal masses, therefore, absorb the same amount of cathode rays. This, of course, is only another form of the statement that the absorptivity and density are proportional to one another.

7. In further experiments, I have compared other solid media, besides metals, with aluminium. The whole surface of the phosphorescent screen was, in the first place, covered with a sheet of ordinary aluminium foil to make the reflection of the screen everywhere uniform. Upon this the sheet (say silver foil) to be examined was placed, so that it covered the half of the screen, the other half being covered with aluminium foil. By the addition of more leaves of aluminium foil the shadows were made as nearly as possible equal. The thickness of an aluminium plate equivalent to the plate being examined, was thus ascertained.

These experiments have shown that as a first approximation the law of the proportionality of the absorptivity to the density, holds for bodies so different from metals as paper, glass, collodion, mica; they have, however, also undoubtedly shown that small deviations from that proportionality do exist. These deviations appear also to be different for different kinds of cathode rays, for it often happened that exactly equal shadows could be again distinguished as different when the pressure in the tube varied.

The following are some of the results of these experiments:—

The thickness of the metals is adjusted to make them of the same transparency.

Table VI.—Leaf Metal and Aluminium.

Thickness		Ratios of the thicknesses.
Of the leaf metal.	Of the aluminium.	
mm.	mm.	
0·000303	0·00128	4·23
0·000455	0·00138	3·03
0·000916	0·00238	2·60
0·000702	0·00262	3·67
0·00281	0·00908	3·23
		Mean 3·35

Ratio of the densities 8·90 : 2·70 = 3·30.

Silver and Aluminium.

Thickness		Ratios of the thicknesses.
Of the silver.	Of the aluminium.	
mm.	mm.	
0·000175 (1)	0·00081 (1·8)	4·60
0·000368 (2)	0·00180 (5·5)	4·89
0·000552 (3)	0·00237 (7·2)	4·23
0·001104 (6)	0·00482 (14·7)	4·37
0·00207 (11·8)	0·00872 (17)	4·22
0·00206 (1)	0·00942 (4)	4·57
0·00210 (12)	0·00970 (20)	4·62
		Mean 4·507

Ratio of the densities 10·5 : 2·70 = 3·89.

Gold and Aluminium.

Thickness		Ratios of the thicknesses.
Of the gold.	Of the aluminium.	
mm.	mm.	
0·000652	0·00525	8·05
0·00135	0·01035	7·67
0·001304	0·01043	8·00
0·001956	0·01440	7·36
		Mean 7·77

Ratio of the densities, 19·3 : 2·70 = 7·15.

The third column gives the relative thicknesses of the aluminium and the metal tested.

In the case of leaf metal (copper with a little zinc), the agreement of the ratios of thicknesses was not very good; the reason was that the sheets of this metal employed were not of equal thickness. The agreement of the mean ratio with the ratio of the densities is, however, remarkably good. In these experiments the mass of the unit area of the metal leaves was determined directly by weighing. The mass was sufficient for our purpose; only, to illustrate the point better, the thicknesses were calculated. The absorptivity of imitation gold leaf comes out as 3·35 times that of aluminium (Table V.), therefore equals 23,800 cm^{-1}.

Better results were obtained with the very uniform silver foil (Table VI). Every care was taken, by weighing, to make the thickness of the sheets employed uniform. Now, in this case there is undoubedly a disagreement between the ratio of the absorptivities and the ratio of the densities. All the ratios of thicknesses are distinctly greater than the ratio of the densities. The number of leaves or layers used in each case is indicated by the figures within brackets; the fractions indicate very thin leaves added to make the

final adjustment. The number of leaves used seems to exercise no influence on the result. The absorptivity of silver is 4·507 times that of aluminium, and is, therefore, equal to 32,200 cm^{-1}.

Also, in the case of gold (Table VI.), there is a small deviation of the thicknesses from the density ratio, and in the same sense as with silver. The absorptivity of gold is 7·77 times that of aluminium, and is, therefore, equal to 55,600 cm^{-1}.

With non-metallic solid bodies the following results were obtained :—

TABLE VII.

Substance.	Mass of unit area. d. substance. s.	Mass of unit area. d. aluminium a.	Density of the substance.	Absorptivity. $\frac{a}{s} \cdot \frac{d}{2{\cdot}70} \cdot 7150$
	mg/cm².	mg/cm².	g/cm².	cm^{-1}.
Collodion film	1·04	1·24	1·10	3,310
Silk paper	2·05	1·60	1·30	2,690
Glass	1·75	2·09	2·47	7,810
Aluminium	—	—	2·70	7,150
Mica	3·16	3·00	2·80	7,250

The masses of a unit area, s and a, of equally transparent layers, are here placed in adjacent columns ; these values are nearly equal, the values of the absorptivities in the last column increase proportionally with the densities, in spite of the great difference of the substances. Special care was exercised in obtaining uniform sheets of the substances, and in ascertaining their densities.

8. We shall now, finally, bring together the absorptivities, the densities, and the quotients of the two, for some of the gaseous bodies that have been investigated, and for all the solid bodies examined. It will then be seen how far they correspond with our original proposition.

Substance.	Absorptivity.	Density.	Absorp. Density.
	cm^{-1}	g/cm^{-3}	g^{-1}/cm^2
Hydrogen of 3·3 mm. pressure (Table II.)	0·00149	0·000000368	4,040
Atmos. air of 0·78 mm. pressure (Table I.)	0·00416	0·00000125	3,330
Hydrogen of 760 mm. pressure (Tables II. and IV.)	0·476	0·0000849	5,610
Atmos. air of 760 mm. pressure (Tables I. and III.)	3·42	0·00123	2,780
Sulphurous acid of 760 mm. pressure (Table IV.)	8·51	0·00271	3,110
Collodion film (Table VII.) ...	3,310	1·10	3,010
Paper (Table VII.)	2,690	1·30	2,070
Glass (Table VII.)	7,810	2·47	3,160
Aluminium (Table V.) ...	7,150	2·70	2,650
Mica (Table VII.)	7,250	2·80	2,690
Imitation gold leaf (Table VI.)	23,800	8·90	2,670
Silver (Table VI.)	32,200	10·5	3,070
Gold (Table VI.)	55,600	19·3	2,880
		Mean	3,200

It is to be noted that these results hold only for the kind of cathode rays used in these experiments.

AN ELECTRO-MAGNETIC CONDUIT SYSTEM.

SOME few weeks ago we described in these columns the Westinghouse magnetic conduit system. The one which we now mention is the electro-magnetic railway system, and is due to Mr. J. F. McLaughlin, of Philadelphia. Practically the only point of resemblance between this and the Westinghouse method lies in the switch or junction box, and for the following description we are indebted to the columns of the *Electrical Engineer* of New York.

The E. M. railway system consists essentially of a conductor laid in sections flush with the pavement, midway between the rails, which sections are not part of the circuit, and hence are dead, under normal conditions ; only when the car approaches a section does it become live, remaining so until the car has passed over the section, when the latter is again disconnected from the live feeders, and becomes dead ; all these operations being performed automatically.

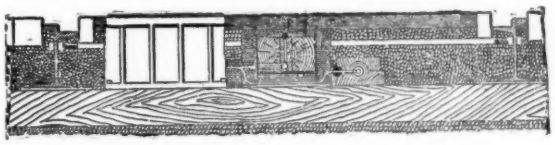


FIG. 1.—SECTION OF CENTRAL CONDUCTOR, RAIL, &C.

The operation of the system will be readily understood by reference to the accompanying engravings.

Fig. 1 shows the central conductor or rail in section, and fig. 2 a plan view of the track construction. This central conductor is a 3-inch I beam, with a flat top $2\frac{3}{8}$ inches wide. The sections are 11 feet long, and are spiked to the top of a creosoted stringer, as shown in fig. 1. The sections are separated by an interval of 1 foot. The longitudinal stringer

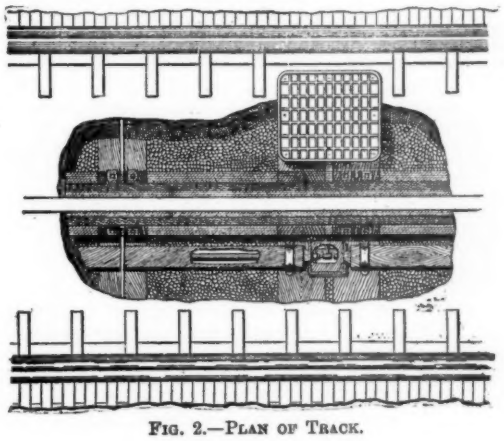


FIG. 2.—PLAN OF TRACK.

is set in cast-iron chairs, carried upon the cross ties, a chair being placed upon every third tie. Tie rods extend from each side of these chairs to the outer rails of the track.

The sections of the central rail are connected through junction boxes, one for each section, with what is known as

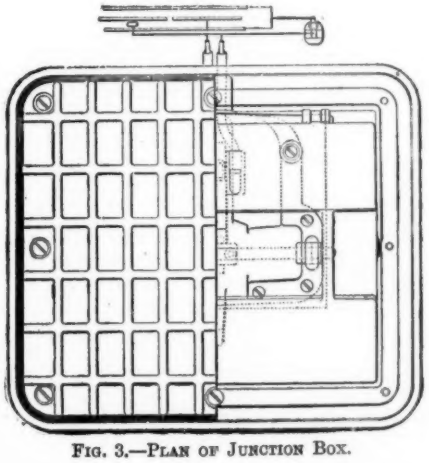


FIG. 3.—PLAN OF JUNCTION BOX.

the distributing conductor, which is laid alongside the longitudinal stringer underneath the pavement, above the ties, as shown in fig. 1. The sectional rail end of the connection is made by means of a connector screwed through a hole in the bottom of the longitudinal stringer into the under side of

the rail. Through a lateral opening in the longitudinal stringer, a second connector is screwed into the first one, and to the outer end of this, by means of an ordinary coupling, is attached a lead-covered cable which leads directly into the junction box. The connection is made with the distributing main in a connecting box, as shown in fig. 2, and from this a lead-covered cable leads underneath the longitudinal stringer and into the junction box. The opening through which these two cables pass into the junction box is shown in fig. 3, this opening being hermetically sealed, so as to keep the inside of the junction box thoroughly dry.

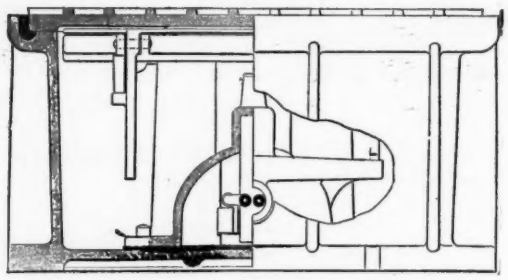


Fig. 4.—Longitudinal Section of Junction Box.

Fig. 3 shows a plan view of the junction box, with one-half of the cover removed; fig. 4 a longitudinal section, and fig. 5 a transverse section of the same box. This box has a cast-iron case, the cover of which is a composition of iron and brass. This can be hermetically sealed, so that no moisture can get into the box. Practically, all that this box contains is a jack knife switch, with means for opening and closing it to cut out and in the sections of the central contact rail. The mechanism for operating this switch, which is shown in fig. 5, is exceedingly ingenious. The blade of the switch is hung vertically from a horizontal axis, the latter being near the top of the junction box, while the contact points of the switch are near the bottom, thus securing a long leverage for working the arm of the switch. This arm is placed underneath a case made of cast-iron and approximately of bell shape, as shown in section in fig. 5. The axis upon which the switch blade is hung is the only part which projects through this bell-shaped case. Across the ends of this axis extend two arms, which are connected at their ends by two cast-iron plates. In fact, these plates, and the arms to which they are attached, are made in one piece. It is evident that an up-and-down motion of these plates will close and open the switch alternately, thus cutting in and out the sections of the central rail. Just how this up-and-down motion is produced will appear when the electro-magnets carried upon the car are described.

A very ingenious feature of this junction box mechanism is the provision made for locking the switch in its "out" position, so that it is absolutely impossible for the circuit to become closed, and the central rail to be made "alive," except by the passage of an energised electro-magnet over the top of the junction box. In the position of the switch shown in fig. 5, the circuit is closed and the switch, of course, in its unlocked position. When the swinging plate on the right is depressed, the switch will be opened, and the latch, shown on the right just above the opening through which the cables pass, will drop into its position and be held firmly in place by the action of gravity on the upper and thinner locking plate. This plate, as will be seen in fig. 5, is rigidly attached to the locking arm at the right and turns about a centre in the outer edge of the tilting arm. A second, or interior case, is placed upon a layer of asbestos, which thus intervenes between the blades of the switch and the outer cast-iron shell of the box.

A side view of the car in fig. 6 shows the location of the trolley contact and of the pair of large electro-magnets which operate the junction box switches. These magnets are carried at opposite ends of the track, a distance of 13 feet apart between centres. They are ordinary inverted horseshoe electro-magnets, the pole faces of which are carried at a distance of 3 inches above the top of the junction box cover. The magnets are carried, of course, upon the truck frame in such a way as to be subject to a very slight oscillation. The armatures upon which these electro-magnets act are the tilting plates in the junction boxes. The magnets are both

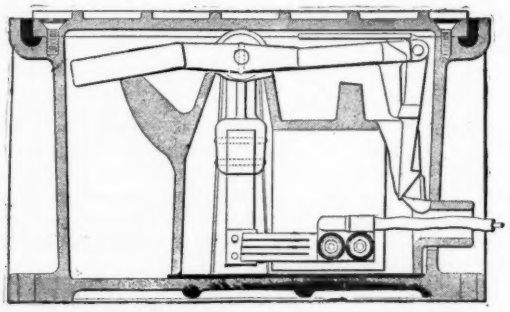


Fig. 5.—Cross-Section of Junction Box.

placed upon one side of the centre rail, and so placed that one of them will pass directly over one end of the tilting arm, while the other coincides in position with the opposite end of the arm.

These magnet coils are connected across the circuit between the trolley—that is, the central rail—and the ground, which in this case, as in the ordinary trolley system, is the track rail and such supplementary circuits as may be used. The operation then is as follows, assuming that there is current in the distributing conductor, and in one section of the central rail, and that the trolley is in contact with this live

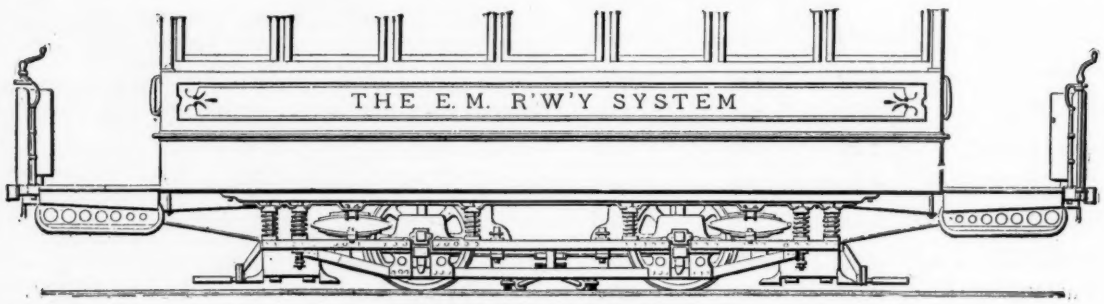


Fig. 6.—Method of Making Contact.

section: The forward end of the car passes over the junction box of the next section and the energised electro-magnet, pulling upon the tilting armature, closes the circuit, making the next section of the central rail alive. The forward half of the trolley is in contact with this rail, and the car takes its current from this source, and the rear half of the trolley then leaves the preceding section as the car moves along. The electro-magnet at the rear of the car then passes over the tilting armature of the junction box corresponding to the section of the rail which the car has just left, pulls open the switch and cuts out that section. This same operation is repeated for every section that the car passes over. It should be noticed that not more than two sections are alive at any one time; that the maximum length of live conductor is, therefore, 23 feet; that the current is cut into the section in advance before the trolley has left the preceding one, and that the rear section is inactive; that is, the trolley has left

it before it is cut out of the circuit. This latter arrangement is intended to obviate the possibility of an arc at the junction box switch.

An arrangement has been devised, which is not shown in the illustration, for shifting the electro-magnets, so that they may be made to pass over opposite sides of the junction boxes, and so that they may be made to follow the line of the junction boxes at crossovers, switches, and similar places.

Fig. 7 shows a diagrammatic view of the connections, where these are shown so clearly that very little explanation is necessary. This shows that the track rails are connected

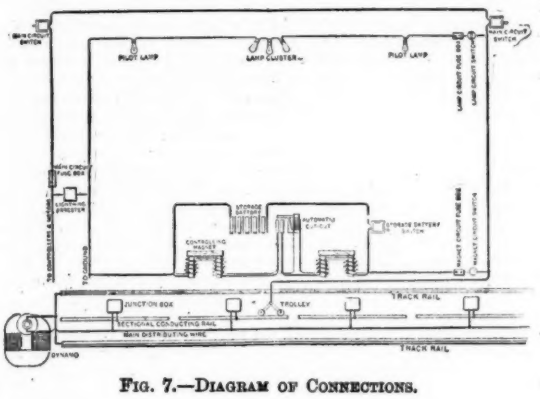


Fig. 7.—Diagram of Connections.

to one side of the generator and the main distributing wire which connects through the junction boxes with the central rail leads to the opposite terminal of the dynamo. The controlling magnets are wound with fine wire, and are in series with each other and with an automatic cut-out which opens the circuit, if for any reason the current is interrupted through the coils of the controlling magnets. At the same time it throws into circuit a bank of five storage batteries which are connected through a second and coarse winding on the controlling magnets. Fig. 8 shows a detail of this cut-out, the object of which is simply to provide a

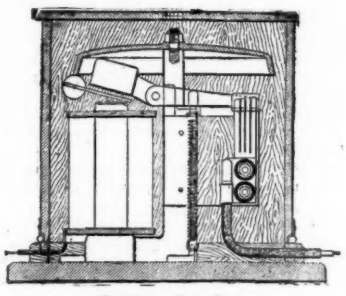


Fig. 8.—Cut-Out.

means of controlling in an emergency the junction box switches, when from any reason, such as the blowing of a fuse, the electro-magnet might become de-energised.

The track construction contemplated for this system is shown in fig. 1, where the entire space between the rails is filled with cement, except the street surface, which is asphalt. Vitrified brick is used along the rails. The company contemplates the use of a 500-volt current, and does not anticipate any difficulties arising from leakage or the possibility of short circuits between the live sections of the central rail and the track rails.

The Electro-Magnetic Traction Company is represented in this country by Messrs. Johnston & Farie, of Glasgow.

LONDON COUNTY COUNCIL.

Electric Lighting Notices.

The following paragraphs in the Highways Committee's report were passed on Tuesday by the Council without any comment. Probably the noteworthy feature in connection with these items is found in the reference to the use of the Crompton-Davies casing.

1. We have considered a notice, dated January 9th, from the County of London and Brush Provincial Electric Lighting Company, under the Wandsworth Electric Lighting Order, 1892, of intention to construct 38 large transformer boxes in the Wandsworth district in the positions shown approximately on a plan submitted with the notice. We are informed that the proposed positions of these boxes have not yet been approved by the Wandsworth District Board, and in order that the district board may have a free hand in the matter, we think that the Council's approval should be withheld for the present. We accordingly recommend that the Council do formally disapprove the works referred to in the notice, dated January 9th, of the County of London and Brush Provincial Electric Lighting Company.

2. We have also considered a notice, dated January 15th, from the Vestry of St. Pancras, under the provisions of the St. Pancras Electric Lighting Order, 1883, of intention to lay mains across Great College Street. We recommend that the Council do approve of the works referred to in the notice, dated January 15th, of the Vestry of St. Pancras, under the provisions of the St. Pancras (Middlesex) Electric Lighting Order, 1883.

3. Three notices, dated respectively 15th, 22nd, and 22nd January, have been received from the House-to-House Electric Light Supply Company, of intention to lay (*a*) high and low tension mains in Evelyn Gardens and across it in two places, and across Cranley Gardens, and a low tension main in Cranley Gardens, and to construct three transformer street boxes of small size, and three surface boxes; (*b*) low tension mains in 4-inch cast-iron pipes across Sussex Place; (*c*) high and low tension mains in Fulham Road. The works are similar to those approved under previous notices of the company. We recommend that the sanction of the Council be given to the works referred to in the notices, dated respectively 15th, 22nd, and 22nd January, from the House-to-House Electric Light Supply Company, upon the following conditions:—That the company do give two days' notice to the Council's chief engineer before commencing the works; that the mains be laid under the footways wherever it is found practicable to do so; that the low tension mains be placed at least 9 inches below the underside of the paving, and those of high tension at least a foot lower; that no pipes of a larger diameter than 4 inches be used; that no street boxes or transformer boxes be constructed until full details shall have been submitted to and approved by the Council's chief engineer; that separate boxes be used for the high and low tension mains respectively; that, as an additional precaution against accident through defective insulation of the mains, each of the street boxes be provided with an inner cover sheathed with wood or other non-conducting material, as well as an outer cover, the two insulated from each other as far as practicable, the outer cover being efficiently connected to earth; and that adequate means be taken to prevent the accumulation of gas in the boxes and conduits.

4. The London Electric Supply Corporation has given a notice, dated January 18th, of intention to lay distributing mains, consisting of lead-covered concentric cable drawn into cast-iron pipes, in Battlebridge Lane, Tooley Street. We recommend that the sanction of the Council be given to the works referred to in the notice dated January 18th, from the London Electric Supply Corporation, upon the following conditions:—That the company do give two days' notice to the Council's chief engineer before commencing the works; that the mains be laid under the footways, and be kept 9 inches below the underside of the paving wherever it is found practicable to do so; that where the mains cross the carriage way they be kept at the same depth below the concrete or the road material, as the case may be; that no pipes of larger size than 5 inches be used; that no street boxes be constructed until the positions for, and the mode of construction of them, shall have been submitted to and approved by the Council's chief engineer; that all pipes or openings from or into the boxes be of such shape as to remove all risk of injury to the covering of the cables; that all cables crossing the boxes be supported from below in the boxes; that all service lines or small cables be protected, where leaving the boxes, by an extra lead covering, or by wooden stoppers, and also have a copper wire of sufficient size carried from the service to the main cable, in good connection with the lead or iron outer casing; that the ends of all mains terminating elsewhere than in a box be securely protected by iron caps, in addition to any other covering, and that as an additional precaution against accident through defective insulation of the mains, each of the street boxes be provided with an inner cover sheathed with wood or other non-conducting material, as well as an outer cover, the two to be insulated from each other as far as practicable, the outer cover being efficiently connected to earth, and that adequate means be taken to prevent the accumulation of gas in the boxes and conduits.

5. A notice, dated January 21st, has been given by the Westminster Electric Supply Corporation, of intention to lay mains in South Eaton Place and across it in two places. The proposed mains will be laid in Crompton-Davies three-way cast-iron casing under carriageways and Doulton three-way casing under footways. We recommend that the sanction of the Council be given to the works referred to in the notice dated January 21st, 1896, from the Westminster Electric Supply Corporation, upon the following conditions, that the company do give two days' notice to the Council's chief engineer before commencing the work; that the mains be laid under the footway wherever it is found practicable to do so; that the details of the street boxes to be used be submitted to and approved by him before the work is commenced; that the covers of the boxes do consist of iron frames filled in with material to suit the paving; and that adequate means be taken to prevent the accumulation of gas in the boxes and conduits.

Horseless Vehicles.

The Council passed the following paragraph contained in the report of the Parliamentary Committee:—

We have considered the resolution passed by the Council on December 17th last, requesting us to approach the Government with

a view to the reintroduction in the session of 1896 of a Bill to amend the law with respect to the use of locomotives on highways, and have directed a letter to be addressed to the Government on the subject. We have also requested the members of the Council who are members of the House of Commons to use their best endeavours to further the desired legislation.

LEGAL.

Hall *v.* Alabaster & Co.

This action came on for hearing before the Lord Chief Justice and a special jury, in the J.B. Division on Monday and Tuesday last, it being an action brought by Mr. Henry Cuthbert Hall, an electrical engineer, residing at Eversley, Elanfield Road, Bromley, against the defendants, the proprietors and publishers of the Electrical Review, to recover damages for an alleged libellous article headed "Storage Battery Testing Extraordinary," published in the Electrical Review on April 26th, 1895.

The plaintiff alleged that the article conveyed the innendo that he was ignorant and incompetent as an electrical engineer, and that he was not capable of testing a storage battery, or of making a reliable report thereon; that he was not an expert electrical engineer, and that his report was not made honestly, but contained untrue, reckless, and misleading statements made by him, with a view to persuading persons to take up the manufacture to which the same related, and with the object of disparaging the manufacture of a rival invention.

The defendants, by their defence, while admitting the printing and publishing of the words complained of, denied the alleged innendos. They also alleged that the words compained of, in so far as they consisted of matters of opinion, were fair and *bonâ fide* comments upon matters of public interest which did not exceed the limits of fair criticism, and which were printed and published *bonâ fide* and without malice. They also further pleaded that in so far as the words complained of consisted of matters of fact, they were true in substance and in fact.

Mr. Lawson Walton, Q.C., M.P., Mr. Scott Fox and Mr. Oppé (instructed by Messrs. Freeman and Bothamley), appeared as counsel for the plaintiff; and Mr. H. H. Asquith, Q.C., M.P., and Mr. John Eldon Bankes (instructed by Messrs. Lewis & Lewis), represented the defendants.

Mr. Lawson Walton, Q.C., in opening the case, said that the plaintiff was an electrical engineer, and the defendants were a trade journal called the Electrical Review, and the plaintiff by his action sought to recover compensation against the defendants for a publication which reflected both on his professional conduct and upon his professional integrity. The issues sought to be raised were (1) whether the criticism to which the defendants had subjected the plaintiff was fair; and (2) whether the statements on which they founded that criticism were true in relation to the plaintiff's action and in relation to the experiments which he described. Mr. Cuthbert Hall was a young man who had been for some years qualified as an electrical engineer. He had given considerable attention to electrical storage, and had pursued his researches with such success, as to obtain some degree of eminence in his profession. He was one of the arbitrators attached to the London Chamber of Commerce in connection with the electrical department, the editor of a professional journal known as *Electrical Industries*, and he had acquired a professional connection which was to him the source of a professional income, on the continuance of which his commercial prosperity depended. The defendants were a trade journal, and their news columns were largely devoted to describing the machines and operations which they advertised. The jury would have to decide the attack which they had made upon the professional character and professional conduct of Mr. Hall could be said to be justified. In 1894 Mr. Hall was invited by Mr. Higgs to conduct certain tests of a new storage battery which Mr. Higgs was interested in, and he undertook to investigate the scientific claims and merits of these batteries, which he would call the International Electrical Storage batteries. For that purpose he was furnished with some 11 I.E.S. batteries, and had placed at his disposal the works of the I.E.S. Company, that company being the proprietors of the patent, and the manufacturers of batteries in conformity with it. These experiments lasted for a considerable time, and while they were in progress Mr. Higgs was furnished with the results. After some little time Mr. Higgs suggested, and Mr. Hall accepted the suggestion, that the battery of the Electrical Power Storage Company, known as the E.P.S. battery, should form the standard of comparison. That was convenient and fair; convenient because the E.P.S. battery was known to every engineer, and fair because the capacities and various powers of the E P.S. batteries were all published in the catalogues of the E.P.S. Company, and, therefore, ready to the hand of anyone familiar with the subject. The learned counsel then explained that a secondary battery was a battery which stored electricity which had been generated, and after a few words about measuring the capacity of different batteries, went on to give the results of Mr. Hall's experiments. Mr. Hall, he said, took the new battery, and very largely increased the rate of discharge which was applicable to the E.P.S. battery, and he found that the new battery continued at this very high rate of discharge for a very considerable period, and at the end of that period was in a thoroughly efficient and capable condition. He took the old battery, and increased the rate of discharge very largely over the figure at which the maximum rate of discharge was published as available, and he found that instead of lasting for 10 hours, it ran down in 20 minutes, and that the plates themselves buckled up; in other words, that the battery was not capable of discharging at all at the same rate as the new battery was, and that the period of discharge in the case of the old battery was very short as compared with the new. It became necessary to tabulate those results, and Mr. Hall, having arrived at certain figures which showed the superiority of the new battery over the old, at the request of Mr. Higgs, embodied the results of his experiments in a letter or report which he sent to that gentleman. The learned counsel read the report, and went on to say that it was given to Mr. Higgs, and was not a public report. How it got into the hands of the defendants Mr. Hall could only speculate. Mr. Higgs had it, and said he sent copies to a few friends of his. By some means the defendants got hold of this memorandum, and having got it, they thought it afforded an opportunity for smart writing at the expense of the youthful engineer who had made these experiments.

The Lord Chief Justice: No doubt Mr. Higgs would have made it public.

Mr. Lawson Walton said probably that was so, but in this form it was not prepared by Mr. Hall for general publication, it was only a communication intended to be read, and to guide the action of certain gentlemen who had engaged Mr. Hall, and who had themselves seen the way in which these tests were being carried out. The defendants having got hold of this report, proceeded to indulge in a little smart and slashing writing, in which Mr. Hall's reputation as a man of honour, and a scientific man, were sacrificed, as would be seen from the libel. The learned council then read the libel, and contended that it suggested that Mr. Hall did not possess the most ordinary capacity for conducting a professional investigation, that he was reckless and unskilful, that his results were worthless, and that the mode in which he stated them would damn any invention, and that he had unscrupulously allowed himself to be the tool of a man who was seeking to foist on the public a worthless invention. The learned counsel then fore-shadowed the evidence which would be given, and detailed the steps which led up to the action, and concluded by saying that he should ask the jury if they came to the conclusion that the attack upon Mr. Hall was not fair journalism, to mark their sense of such conduct by a verdict which would do justice to his client.

Hearing adjourned.

Second Day.—January 28th.

The plaintiff, examined by Mr. Lawson Walton, said that he was a consulting engineer in connection with electricity and electrical appliances, an associate of the Institute of Electrical Engineers, and editor of *Electrical Industries*, and one of the arbitrators in the London Chamber of Commerce in the Electrical Section. Although he had only been in practice since 1892 as a consulting engineer, his experience dated from 1886. He had paid considerable attention to storage batteries. In 1894 he had a conversation with Mr. Higgs with reference to a battery in which he was interested, and Mr. Higgs made various statements to him with regard to the capacity of the instrument and the fall of electrical pressure. He (witness) thought it very improbable that the cell had the capacity which Higgs stated it to have, and upon his telling Higgs his opinion, the latter told him that he would send cells for him to test. In May, 1894, Higgs sent two cells for him to test. After he had made a preliminary test in May, 1894, and finding that the cell had very extraordinary capacity, it was arranged that he should make a series of elaborate tests, and the tests so made should be made the subject of a paper which he proposed to read at the Institution of Electrical Engineers.

In answer to his Lordship, the Witness said that he did not know at that time whether the cell was patented or not. It was not discussed at all, or who owned it.

Examination continued: His remuneration was agreed at 25 guineas. Having made those arrangements, 11 cells were provided for him at some works of the I.E.S. Company at Euston Buildings. That was about the beginning of November, 1894. The 11 cells were all arranged in series, each cell having three plates in all, one positive and two negative. Before he began to tabulate the tests, he found that the cells were in working order. He had a recording voltmeter to take the pressure at the terminals of the whole battery, an amperemeter to take the current. The record of those two instruments enabled him to tell the current of electricity the cell gave birth to; they enabled him to see what the capacity of the cell was. A small cell tester was used to take the pressure of each cell. His assistant was instructed to try each cell from time to time, to see if each one was doing its share of the work. He (witness) began with low rates, and charged and discharged at those low rates some considerable time, and then the rate was raised step by step. The result was that the cells bore the high rate. He kept notes of the tests, and Mr. Higgs was shown some of the curves from time to time. Mr. Higgs then wished a comparison made with some existing battery in the trade. The battery he took was the L type of battery, referred to in the catalogue issued by the E.P.S. Company, which was the most favourable in the point of high rate of discharge and high capacity combined. In response to Mr. Higgs's wish, he made out figures showing the results of the work of the new battery as compared with the previous capacity of the old battery. In comparing those two batteries, he did not consider that it was an essential feature, or important feature, to give the absolute size of the old battery, with which the comparison was made. He furnished Mr. Higgs with the results of his tests in a letter which he wrote to him on March 21st, 1895. For the purpose of comparison, he reduced the areas of the I.E.S. cells to square inches, and the areas of the E.P.S. cells to square inches, and having done so, he compared the rate per square inch of the one with the rate per square inch of the other. He considered that perfectly intelligible and perfectly fair. There was

no ground for the suggestion that the I.E.S. cells suffered injury at the high rates.

In answer to his LORDSHIP, the WITNESS stated that his definition of "capacity" was measuring the output of the batteries in amperes.

Examination continued: The discharge showing the result was not an isolated experience. The discharge was repeated over and over again until the same conditions were reproduced. After that, he felt justified in saying that the cell had a certain capacity at those rates. He tried the E.P.S. at 10 times the maximum allowed by the makers. He did not force the I.E.S. to their utmost maximum. The report was dictated by him and type written, and then sent to Mr. Higgs. It was not prepared by him with a view to general publication. He knew that Mr. Higgs was interested in the cell from the beginning.

By His LORDSHIP: He did not know that Mr. Higgs wanted the figures for the purpose of showing them. Higgs did not tell him that he was going to show them. At the time that Higgs asked him for the results he (witness) thought they were only for his own personal information. In addition to the figures which appeared in the report, he had his own notes and own curves and own data, he had kept for the purpose of preparing a report on the subject. He did not continue the tests beyond a certain time, because the works were removed to Woking. When he first began the experiments he had meant to make very elaborate tests. He gave Mr. Higgs such results as he thought reliable up to that time. He had meant to analyse the internal resistance of the cell and make it of scientific interest. He was not called upon by the defendants to show the results to them, and he received no communication from them to the effect that they were going to criticise the report, nor did they ask his permission to do so. He had no knowledge that Higgs had parted with it, or shown it to anybody. He did not wish the report to be published as a scientific report. Mr. Higgs was familiar with the tests he had employed. He emphasised to Higgs that isolated tests were valueless. He explained to him that he had taken repeated charges and discharges. The size of the cell was absolutely immaterial. There was no ground for the suggestion that he had suppressed the fact that the cells had been damaged. The cells were not damaged. The experiments lasted altogether for three months. He had absolutely no sort of interest in the success of the battery in question. It was untrue to say that his results were erroneous or reckless.

Cross-examined by Mr. ASQUITH, WITNESS said that his report was intended to convey an idea to commercial men of the value of the I.E.S. cell. He thought Mr. Higgs wanted it for his own information; but if he had been asked whether it was likely that Mr. Higgs would show it to other people, he should have said it was. It was always intended that the results of his experiments should be published, but witness did not ask for remuneration until the appearance of the article complained of as a libel. The report was intended as a report to Mr. Higgs, and not as a public report. The cells and materials used by him were placed at his disposal by the I.E.S. company. Asked if it was not in reference to the use of the battery for traction purposes that his experiments were conducted, and his report made, witness said no, but it had a particular value for traction purposes. At the present moment the application of electricity for traction purposes was one of the most difficult and important operations in the electrical world. He thought E.P.S. cells had been used for traction purposes. The three things essential for traction purposes were high capacity, mechanical durability, and light weight. Upon every one of those points, he said and thought the I.E.S. cell was the best now before the world. There were 11 cells in the battery, and three plates in each cell. He could not say whether there was such a thing known to the market as a cell of the E.P.S. type used for practical purposes containing as few as three plates. The E.P.S. cells had to have a great number of plates because their capacity was low. The number of plates was a question of capacity. In connection with his experiments in this instance he did not test an E.P.S. cell, but he had tested E.P.S. cells over and over again, and his reference to the makers would, he thought, prevent a commercial man from drawing the inference that he had experimentally contrasted the results given by the E.P.S. and I.E.S. cells. He was aware that there were a great many types of E.P.S. cells, but he took the L type instead of the K type, because that was recommended by the E.P.S. Company, and his experience was that at a higher rate of discharge than 4 amperes there would be injury to the plate in the way of reduction in capacity. It might be that the E.P.S. cells were in practice discharged at five or six times their normal maximum capacity, but that was contrary to the directions of the makers. He selected the L type of the E.P.S. Company because what was wanted for traction purposes was a high rate of discharge and a high capacity combined, and at any rate of discharge the L type had a higher capacity than the K. The E.P.S. Company themselves recommended the L plate, where these things were wanted in combination. He did not think he ought to have stated in his report the type of E.P.S. cell he had selected. He expected a commercial man would assume from his report that the I.E.S. cell was for several reasons the best cell he had ever tested for traction purposes. The L type was better than the K type, although the report was silent about the L and K types. His experiments were carried out by his assistants, he himself going to the works four or five times. The measuring instruments were supplied by the I.E.S. Company. He had discharged E.P.S. cells at about five times the rate allowed by the makers, with the result that there was a remarkably low capacity, and the peroxide was loosened. He believed the plates of the I.E.S. cells were encased in celluloid for the purpose of giving mechanical support, but such encasing was unnecessary.

Mr. LAWSON WALTON said the envelope was no part of the patent.

WITNESS then gave categorically reasons for the statements in his report, and said that he did not know of an I.E.S. battery ever being used for traction purposes. He did not report on the merit of such a battery for traction purposes in every respect. When a battery was used for locomotive purposes it was exposed to vibration and shocks which would not occur in a laboratory, and all these things involved irregularities in the rate of discharge, and very great mechanical strains. Under these circumstances, the mechanical structure of batteries of this kind for traction purposes was very important. A cell which was constructed to a large extent of celluloid was mechanically stronger than one of lead, because in acid the lead underwent chemical changes. In reporting of the capacity he did not consider the durability of the plates. At that time he could not pass an opinion on the durability of the cells; durability would be shown by experience in working or prolonged experiments. In his report there was nothing to indicate that the E.P.S. batteries were in boxes lined with lead, which weighed nearly two tons, while the I.E.S. batteries were in light ebonite boxes. In his opinion ebonite boxes would stand the wear and tear of tramcar life.

In re-examination WITNESS said he was not invited to report on the actual operation of these batteries in use for traction purposes, and was not concerned with whether they were practicable for that purpose or not. His report did not purport to record any tests of durability, and none would be efficient except tests of actual and yearly use.

Prof. AYRTON, electrical engineer and past president of the Institute of Electrical Engineers, examined, said, that he had had many years' practical experience in secondary batteries. He had had his attention called to the report in question, which had been the subject of criticism in the defendants' paper. He should have thought that if Mr. Hall had imagined that his report was going to be published in a technical paper he would have entered into more details. He (witness) understood Mr. Hall's report quite well. He had heard the descriptions which the plaintiff had given in evidence of the methods of comparison which he had adopted, and he (witness) considered them quite fair. From personal tests which he had made to satisfy himself, Mr. Hall's "results" were not "reckless" or "erroneous." He should say that they were substantially correct.

By His LORDSHIP: He did not test the E.P.S. cells to see what rates they could discharge at without injury. He assumed that the list rate of the makers gave that information, otherwise there was no object in giving the list rates at all.

Cross-examined by Mr. ASQUITH: The list rate was the rate the makers guaranteed the cells to give if long life was desired. What a business man wanted to know was the relative value of the two types of plate, and therefore it did not matter so long as it was correct.

Mr. LIMBREY HIGGS, a solicitor, in giving evidence, and corroborating the evidence of the plaintiff, said that he had a few typewritten copies of the report in question made to send round to some of his friends, but he did not know how the defendants got possession of it. The defendants did not ask his permission to use it.

Cross-examined, the WITNESS said that he supplied copies of the report to Mr. Mayne, of the firm of New & Mayne.

Mr. EVANS, an associate of the Institute of Electrical Engineers, and carrying on business in Palace Chambers, Bridge Street, Westminster, examined, said that for five years he had made a special study of secondary electrical service, and was familiar with the different types of cells in the market. His attention was called to the new I.E.S., and he tested it for his own satisfaction. He conducted the tests independently of Mr. Hall, and in the ordinary scientific way. The results he arrived at corresponded with those arrived at by Mr. Hall, but some of them were slightly better. Substantially the results of his experiments agreed with the plaintiff's. Where they differed the difference was in favour of the I.E.S. cell. He had heard Prof. Ayrton's evidence, and agreed with it in the main.

Mr. CONRADI, an electrical engineer, corroborated Prof. Ayrton's evidence.

Mr. BENN, an electrical engineer, having given evidence to the same effect, the plaintiff's case closed.

Mr. ASQUITH in opening the case for the defendants, said that it had been almost impossible for his learned friends who represented the plaintiff, or himself, in the conduct of the case, not to give it the appearance of a contest of rival claims between two competing batteries, because it was impossible to examine or cross-examine the witnesses who had been called without trenching, at any rate, on that question. That was not in any sense the issue which the jury had to try. The only question that they (the jury) had to consider was first, whether the article in question conveyed the imputations which the plaintiff suggested it did, and secondly, whether that article, in its fair and natural sense, went beyond the limits of fair criticism in a technical journal on a matter of technical interest. He (the learned counsel) should show that the matter was brought before the defendants in the most legitimate way. Mr. Higgs, as they now knew, had a number of copies made of the report, and distributed them amongst his friends, in order to induce them to join the company, and in particular, gave a number of copies to the firm of New & Mayne, who were jointly interested with him in the venture, and were the makers, in fact, of the machine. It happened that a gentleman wishing to purchase some form of accumulator from New & Mayne, sent an agent of his to negotiate about it, whereupon Mr. Mayne, one of the partners, having a pile of Hall's type-written reports handed one across to that gentleman—the agent—who had nothing whatever to do with the ELECTRICAL REVIEW. That document having been handed over to a customer in the ordinary way, that customer brought it to the paper, and, therefore, the document was obtained in the most legitimate manner possible. His learned friend had made another suggestion equally unfounded, namely, that inasmuch as the E.P.S. Company was an advertiser in the ELECTRICAL REVIEW, it was in some way to its interests—a damaging comparison having been made with this rival battery—to get rid of that comparison, and to carry the war into the enemys'

camp. That suggestion was made upon imperfect knowledge, because not only the E.P.S. Company, but the I.E.S. Company, was an advertiser in the columns of this paper. What the defendants did when Mr. Hall's report came into their possession was to send it to a gentleman who they believed to be thoroughly competent, who was undoubtedly a practical expert in matters of this kind, and who was entirely independent of the companies in question, and lived in Bradford, for him to comment upon it. What appeared in the paper was written by Mr. Kennedy under these circumstances, he having no personal acquaintance with the plaintiff. What struck Mr. Kennedy—as it struck a great many other people—was that this report, framed in the manner it was framed, and inducing its conclusions by the process of reasoning which appeared on the face of it, was a report upon which the commercial public, for whom it was intended, would think they could safely act. He should submit that the article did not, and never was intended to convey any imputation upon the honesty or good faith of the plaintiff. As far as he knew the newspaper never had any ground for making any such suggestion, and did not make it upon a fair construction of the article. He thought they would come to the conclusion that what they did say was that there was not on the face of the document sufficient data to support the conclusions the plaintiff sought to erect upon it. Being of that opinion, they thought it was right that the public should have pointed out clearly to them the respects in which the report was deficient. The report was a comparison between the I.E.S. battery and the E.P.S. battery for traction purposes. The E.P.S. battery had the advantage of having been used for traction purposes. The object of the article was to institute a comparison between the batteries for that use, and the points of comparison were (1) capacity, (2) mechanical structure, (3) duration of life, and (4) weight. Those were the points it was necessary to establish in favour of the I.E.S. battery if its superiority over the E.P.S. battery was to be held to be established. Proceeding to deal with the alleged libel the learned counsel said it was natural that a journalist dealing with this question should point out that the report was vitiated by no mention of the type of E.P.S. battery used, and contended that though the I.E.S battery had never been on a tramcar it might have been exposed in the laboratory to longer and more continuous tests than it was. It was true the E.P.S. Company's catalogue warned users of their cells not to exceed the normal rate of discharge, but in connection with the L type they said that under certain conditions the rates of charge and discharge specified might be increased on reference to the advice of the Company, and he should show that E.P.S. cells of every type were almost every day discharged, at four or five times the maximum listed rates without the least injury to the plates. He did not think the writer could be said to have gone beyond the limits of fair criticism when he said that the plaintiff's was a reckless comparison, and his evidence would show that the E.P.S. cells would stand the comparison. The statement in the report that the plaintiff was unable to make a comparison of the capacity of the I.E.S Company's cells with the E.P.S cells at the same rates of discharge, because the E.P.S cell would not stand such heavy discharges, the learned counsel asked the jury to say was a sanguine and reckless statement with reference to a cell which had only been tested in the laboratory, and had never been applied for the purposes of traction at all. Lastly, weight was most important. Surely it was not the act of a careful man to make this comparison without warning his readers that wooden boxes lined with lead were used by E.P.S. Company, while the I.E.S. Company used ebonite boxes, which he thought was one of the flimsiest substances that could be used for this purpose. These were the matters which occurred to the writer of the article and the conductor of the Review to call for strong and severe comment. The report did not give the information it ought to have given, and it omitted to give data which was absolutely necessary to enable the readers to test the justice of the writer's conclusions. If that were so, his clients were strictly within the limits of their province, and it was their duty as journalists to do what they could to point out the defective reasoning of this report, and to warn the public not, upon such materials, to put their money into such a concern as this. He should submit that in doing that they were acting in no improper way, and that they had not exceeded the limits—necessarily wide and elastic—of fair comment on a matter which concerned the public.

Mr. L. Epstein, an electrical engineer, and the inventor of the Epstein cell, said he thought the listed rate of the E.P.S. cells was a practical result, and the report unfairly compared practical results in the case of the E.P.S. cells with theoretical results in the case of the I.E.S. cells. In practice, durability of construction and mechanical strength were the first considerations in traction cells. E.P.S. cells could be discharged for a certain number of times without injury at rates up to three times the normal rate. Epstein cells might be discharged to zero, without taking any harm, within a reasonable time. The mention of the Waddell-Entz cells in the report was misleading, because that was a different type of battery. His experience of celluloid was that it was a most uncertain material, and his firm had discarded it. In his opinion it was premature to recommend such a plate to the public.

Cross-examined: To a certain extent, to discharge E.P.S. cells at a higher rate than that which appeared in the catalogue, was taking a liberty with them, and he would not specially recommend it. He was clearly of opinion Mr. Hall was not justified in drawing the conclusions he did as to practical results for traction purposes from the results of his laboratory tests. There was nothing in the report which had reference to anything but laboratory tests.

The Lord Chief Justice: The complaint is that there being nothing but laboratory tests, the plaintiff ought not to have recommended the battery for practical purposes.

Witness admitted that he published a report by Prof. Ayrton on his cells, which related to laboratory tests, but said he did not go so far as to say that, on account of these tests, his batteries were the most valuable for traction purposes. He put his batteries in ebonite boxes, and they answered in the majority of cases.

Adjourned for the day.

Third Day.—Wednesday, January 29th.

Mr. Frank King, a member of the Institution of Electrical Engineers, and manager of the Electrical Power Storage Company, examined, said that he had had a long practical experience of the cells, and had read the report which Mr. Hall made. In his opinion the value of a cell for mechanical purposes was its mechanical strength. He did not see that the report dealt with the mechanical strength of the cell. Assuming that four discharges of the cell were made, it would not give the plaintiff any idea of its durability—at least 20 discharges would be necessary for that. Discharging at high rates must produce high temperature in the cell. In that particular plate an increase of temperature would soften the celluloid and render it useless in giving additional strength to the plate. It got no advantage therefore from the use of celluloid. He had had a very large and distressing experience in the use of celluloid in the cells. He had used a great number of tons of it. Celluloid had been disregarded as giving an additional mechanical strength to those plates. In his opinion, a report was not justified which recommended the plates for construction purposes which did not deal with the durability or strength of them.

Cross-examined, the Witness stated that his chief criticism to the cell in question was its deficiency in mechanical strength.

Mr. R. E. B. Crompton, an electrical engineer, and late President of the Institution of Electrical Engineers, said he had for 15 years considered the application of electricity for traction purposes. The most important point to be considered in judging of the capacity of a battery for traction purposes were, first, durability and mechanical strength, and, second, high rate of discharge. If the first were sacrificed to the second, the batteries were of no use for traction purposes. He had read Mr. Hall's report, and he agreed with the evidence which had been given by Mr. King. With regard to the employment of celluloid in secondary batteries, he said that he had used it largely, and had been a great sufferer from its continuous failure after it had been exposed for a considerable time to the action of the battery. That celluloid was absolutely useless in a battery was well known to everybody.

Cross-examined: He had not analysed the particular celluloid in use in the I.E.S battery. If it were generally known that celluloid was no use in this connection, he should account for the I.E.S. Company using it by saying it was due to their ignorance. The action of the battery on the celluloid began about nine months from starting. The type of lead cell which he had used from the beginning was being taken up by the largest users of accumulators. Assuming the durability of two cells were equal, the fact that one cell could be worked in practice at high rates of discharge would constitute an exceedingly valuable cell for traction purposes. If you were comparing two cells with equal durability, the usefulness would vary with the capacity for high rates of discharge.

Mr. Tom Ernest Gatehouse, an associate member of the Institution of Civil Engineers, member of the Institution of Mechanical Engineers, member of the Institution of Electrical Engineers, and editor of the Electrical Review, said that Mr. Hall's report was sent to his newspaper in the ordinary way for the Review. It was brought by Mr. Schanschieff, an electrical engineer, who informed him he brought it from Mr. Ward, another electrical engineer. He read the report and sent it to Mr. Kennedy, a contributor to his paper, whom he knew as a thoroughly competent electrician. He had no interest in the I.E.S. or E.P.S. cells, or any other electrical firm.

The Lord Chief Justice: You thought it was a matter of interest in the particular line of industry with which you deal?—Of very great interest.

If these results were reliable it would show there were considerable advantages in this arrangement?—Yes.

In further examination Witness said that he saw Mr. Kennedy's review before it was published, and inserted it after he had read it. He decidedly agreed with the criticisms Mr. Kennedy passed upon it. Witness produced a horse-power diagram showing how irregular was the rate of discharge of a battery during a 19 minutes' run on a tramcar.

Cross-examined: He knew Mr. Hall by name, but he did not know that he was an associate of the same Institution of Electrical Engineers as himself, though Mr. Hall described himself as such, and gave his address. The report purported to be furnished to a private gentleman, but as it was not marked "private and confidential," he assumed it was a public document. Mr. Higgs afterwards wrote a letter to the Electrical Review that it was a private document, but he thought it was all the more justifiable to criticise it because Mr. Higgs stated it was a report for commercial men. In his opinion the vital point was, that Mr. Hall made no experiments on the life of the cell. There was nothing in the report to show that the I.E.S. battery was fit for traction purposes at all. With regard to the suggestion that the alleged libel charged Mr. Hall with foisting a worthless thing on the public, witness said a consulting engineer did not do that, though his report might be used for that purpose.

In re-examination, Witness said that Mr. Higgs's letter was published by him after the issue of the writ. Mr. Hall did not represent, nor did his solicitor represent, that this report was a private document.

Mr. A. Shippey, electrical engineer, of King Street, Cheapside, said that he was employed by Mr. Ward to obtain a light accumulator for him, and in consequence, he called upon Messrs. New & Mayne, of Cannon Chambers, Bridge Street, manufacturers of accumu-

lators. He saw Mr. Mann, the manager, who referred to the report of Mr. Hall, and witness was offered a commission to sell I.E.S. batteries.

Mr. Lawson Walton said that Messrs New & Mayne were making for the I.E S. company, and Mr. Higgs sent them 15 or 20 copies of Mr. Hall's report.

Witness said Mr. New gave him a copy of the report, in order that he might use it for obtaining orders. He took the report to Mr. Ward, who, being a practical man, asked him for curves.

Mr. Rankin Kennedy, of Bradford, and manager of the Phœnix Dynamo Manufacturing Company, said that he had had 18 years experience in electrical matters, and was a pupil of Lord Kelvin. He had been a contributor to the Electrical Review on technical matters, and wrote the article in question. He did not know Mr. Hall, and had no interest in the I.E.S. or E.P.S. cells.

Cross-examined: The report was sent to him without any communication, to treat as he thought proper. He commented on the report, not on the engineer or the batteries. He treated the report as a public document. He had never seen an I.E.S. battery, but he had seen one which was equivalent. Asked what was his ground for saying that the figures in the report were transparently erroneous, witness said that any engineer would know that 5 horse-power batteries would be useless for traction purposes, because three times the normal horse-power of the batteries had to be provided for. The statement that the I.E.S. cell could be discharged to a lower difference of potential than any other cell was erroneous, because he knew many cells which could be discharged to zero without injuring them. The main error in the report was that there were no details given. If he had been informed that Mr. Hall had furnished Mr. Higgs with details, that would very much have modified his opinion. There was nothing in the report to support the statement that the I.E.S. battery was the best for traction purposes.

This concluded the evidence.

Mr. Asquith, in summing up the case for the defence, said the question, and the only question, was whether this article, understood in the sense which an ordinary reader of average intelligence would put upon it, did contain imputations upon the character and competency of the plaintiff which were in excess of fair journalistic criticism. His learned friend opened the case as a case in which a newspaper had by illegitimate means got possession of a private document, and had utilised its columns not for the purpose of fairly criticising the information it contained, but for the purpose of puffing the products of a rival company, which was a large and lucrative advertiser in its columns. The facts made it abundantly clear that this was nothing of the kind. The learned counsel, in continuing, said that there was not a trace or shadow of an attempt by the plaintiff to treat the report as a private communication, and it was impossible to contend, as the plaintiff had done, that it was a private communication of which an illegitimate use had been made. The plaintiff had to satisfy them (the jury) that some improper motive might fairly be attributed to the writer of the article complained of, and that it exceeded the bounds of fair and proper criticism. There were some departments in life with which his learned friend (Mr. Walton) and himself were familiar, in which the rules of fair criticism were construed in the most elastic spirit, and scientific gentlemen like the plaintiff ought to recognise that theory to the full. It was abundantly clear that every reader of the plaintiff's report would assume that there had been an actual comparison between the two types of cells, but they (the jury) now knew that such was not the case. There was no actual comparison at all, because for the purpose of making a comparison between the I.E.S. cell and the E.P.S. cell Mr. Hall relied on some general knowledge of the E.P.S. cells, which he had acquired in days gone by, and on the catalogue containing the listed figures, which he (the learned counsel) supposed he had obtained from the company. He submitted that the plaintiff had failed to make out his case, and that their verdict ought to be for the defendants.

Mr. Walton having replied on the whole case,

His Lordship in summing-up, said that there was no class of cases in which the functions of the judge were so limited, and the functions of the jury so wide as in actions of that kind. The first point was whether the plaintiff's report was or was not a fitting subject for criticism. The plaintiff by his council said it was not, and that it was a private document; also he alleged that it was a matter which did not concern the public, and with which a public journal dealing with those subjects had no legitimate concern. He (His Lordship) had no doubt in his own mind that the plaintiff must have known as a man of common sense and experience that Mr. Higgs was not paying for the report in order to put it in the waste paper basket, or lock it up in a drawer. His Lordship then referred in detail to the evidence which showed how the report came to the defendants' hands, and was handed by Mr. Gatehouse, the editor, to Mr. Kennedy, for criticism. If the matter was one for legitimate criticism, as he (His Lordship) thought it was, having regard to the fact that the question of the secondary batteries or storage batteries was of great importance in the electrical world, the jury had then to consider whether the defendants had gone beyond the bounds of fair criticism. To his mind, the most important part of the article complained of was that in which reference was made to attempts, by so-called expert reports, to foist upon the public a certain manufacture, and it was for the jury to say whether that meant that the plaintiff lent himself to an attempt to foist on the public a worthless invention. There was no evidence for saying that such an imputation could be sustained, and it was without justification; in fact, the learned counsel for the defendants had disclaimed that there was any intention of making it. The question, however, was not the meaning of the writer, but what the words meant to ordinarily reasonable men.

The Jury after a short deliberation returned a verdict for the plaintiff for £100 damages.

Judgment accordingly.

Digby v. Wyatt.

This was an action which came before Mr. Justice Grantham in the Queen's Bench Division on Friday, 24th inst., and which was brought by Mr. T. J. Digby, an electrician, against Mr. Frank Wyatt and his wife, proprietors of the Duke of York Theatre, to recover damages for the detention of certain electrical appliances.

Mr. Candy, Q.C., and Mr. Cannot appeared for the plaintiff, while Mr. Craies represented the defendant.

The plaintiff's case was, that under an agreement with Mr. Horace Sedger he supplied the electric light appliances for the stage during the performances of "Baron Golosh" at the Duke of York Theatre. The piece was produced at the defendant's theatre under an agreement, by which the expenses were to be borne by Mr. Sedger and the defendants. The plaintiff said Mr. Sedger thought he had been released from liability under his arrangements with the defendants, and as he (plaintiff) had failed to come to any arrangement with the defendants with regard to lighting the theatre, he applied to Mr. Sedger for permision to remove his appliances. The defendants refused to allow him to remove the appliances, and the result was, that when he was asked to supply the necessary electrical apparatus for the staging of the "Artist's Model" at the Lyric Theatre, he was compelled to make new arc lamps at a cost of £63.

The defendants, in defence, said the plaintiff was not entitled at any time before May 25th to any of the plant in question. They further said that when the plaintiff produced Mr. Sedger's authority to remove the same, they permitted him to do so.

Mr. Justice Grantham gave judgment for the plaintiff for £10, with costs on the higher scale.

ALTERNATE CURRENT MOTORS.

By W. G. RHODES, M.Sc.,
City and Guilds of London Institute. Central Technical College.

(*Continued from page* 600, Vol. 37.)

From equations (1)—(7) of our last article we can deduce the general equations of the ordinary stationary alternating current transformer and of the induction motor, since each is a particular case of the general alternating current transformer.

Stationary Alternating Current Transformer.

In the ordinary alternating current transformer we know that the primary and secondary frequencies are the same, that is, the slip, k, is unity.

Putting, therefore, $k = 1$ we get:

Primary current is

$$i_0 = -n_0 e \left\{ \sqrt{\rho^2 + \sigma^2} + \frac{1}{a^2 \sqrt{(r_1 + r)^2 + (s_1 + s)^2}} \right\}$$

$$= -n_0 e \left(Y + \frac{1}{a^2 I_1} \right).$$

Secondary current:

$$i_1 = \frac{n_1 e}{\sqrt{(r_1 + r)^2 + (s_1 + s)^2}}$$

$$= \frac{n_1 e}{I_2}.$$

Primary impressed E.M.F.

$$E_0 = -n_0 e \left\{ 1 + \sqrt{r_0^2 + s_0^2} \sqrt{\rho^2 + \sigma^2} + \frac{\sqrt{r_0^2 + s_0^2}}{a^2 \sqrt{(r_1 + r)^2 + (s_1 + s)^2}} \right\}$$

$$= -n_0 e \left(1 + I_0 Y + \frac{I_0}{a^2 I_2} \right).$$

Secondary terminal E.M.F.

$$E_2 = \frac{n_1 e \sqrt{\rho^2 + \sigma^2}}{\sqrt{(r_1 + r)^2 + (s_1 + s)^2}}$$

$$= \frac{n_1 e I}{I_2}.$$

Ratio of currents:

$$\frac{i_0}{i_1} = -\frac{1}{a} \left\{ 1 + a^2 \sqrt{\rho^2 + \sigma^2} \sqrt{(r_1 + r)^2 + (s_1 + s)^2} \right\}$$

$$= -\frac{1}{a} (1 + a^2 Y I_2).$$

Ratio of E.M.Fs.

$$\frac{E_0}{E_1} = -\frac{a}{\sqrt{r^2+s^2}}\left\{\sqrt{(r_1+r)^2+(s_1+s)^2}\left[1+\sqrt{r_0^2+s_0^2}\,\sqrt{\rho^2+\sigma^2}\right] + \frac{\sqrt{r_0^2+s_0^2}}{a^2}\right\}$$

$$= -\frac{a}{I}\left(I_2 + I_0 I_2 Y + \frac{I_0}{a^2}\right).$$

Total apparent impedance of primary circuit :—

$$I'_0 = \frac{1+\sqrt{r_0^2+s_0^2}\,\sqrt{\rho^2+\sigma^2}+\dfrac{\sqrt{r_0^2+s_0^2}}{a^2\sqrt{(r_1+r)^2+(s_1+s)^2}}}{\sqrt{\rho^2+\sigma^2}+\dfrac{1}{a^2\sqrt{(r_1+r)^2+(s_1+s)^2}}}$$

$$= \frac{a^2 I_2 + a^2 I_0 I_2 Y + I_0}{a^2 I_2 Y + 1}.$$

INDUCTION MOTOR.

In the induction motor the secondary circuit is short circuited, so that there is no external secondary circuit.

Putting, therefore, $I = 0$, or its equivalent $r = 0$, and $s = 0$, we get

Primary current :—

$$i_0 = -k\,n_0\,e\left\{\frac{\sqrt{\rho^2+\sigma^2}}{k}+\frac{1}{a^2\sqrt{r_1^2+k^2 s_1^2}}\right\}$$

$$= -k\,n_0\,e\left(\frac{Y}{k}+\frac{1}{a^2 I_1}\right).$$

Secondary current :—

$$i_1 = \frac{k\,n_1\,e}{\sqrt{r_1^2+k^2 s_1^2}}$$

$$= \frac{k\,n_1\,e}{I_1}.$$

Primary impressed E.M.F. :—

$$E_0 = -n_0\,e\left\{1+\sqrt{r_0^2+s_0^2}\,\sqrt{\rho^2+\sigma^2}+\frac{k\sqrt{r_0^2+s_0^2}}{a^2\sqrt{r_1^2+k^2 s_1^2}}\right\}$$

$$= -n_0\,e\left(I + I_0 Y + \frac{k I_0}{a^2 I_1}\right).$$

Secondary terminal E.M.F. :—

$E_1 = 0$.

Ratio of Currents :—

$$\frac{i_0}{i_1} = -\frac{1}{a}\left\{1+\frac{a^2}{k}\sqrt{\rho^2+\sigma^2}\,\sqrt{r_1^2+k^2 s_1^2}\right\}$$

$$= -\frac{1}{a}\left(1+\frac{a^2}{k}\,Y\,I_1\right).$$

Ratio of E.M.Fs. :—

$\frac{E_0}{E_1}$ = infinity.

Total apparent primary impedance

$$I'_0 = \frac{1+\sqrt{r_0^2+s_0^2}\,\sqrt{\rho^2+\sigma^2}+\dfrac{k\sqrt{r_0^2+s_0^2}}{a^2\sqrt{r_1^2+k^2 s_1^2}}}{\sqrt{\rho^2+\sigma^2}+\dfrac{k}{a^2\sqrt{r_1^2+k^2 s_1^2}}}$$

$$= \frac{a^2 I_1 + a^2 I_0 I_1 Y + k I_0}{a^2 I_1 Y + k}$$

Let us now return to the general problem, and let us suppose that we can neglect the exciting current. This assumption is equivalent to putting

$$Y = 0.$$

We get, therefore,

$$E_0 = -n_0\,e\left\{1+\frac{k I_0}{a^2 I_2}\right\}$$

$$E_1 = \frac{k\,n_1\,e\,I}{I_2}$$

$$i_0 = -\frac{k\,n_0\,e}{a^2 I_2}$$

$$i_1 = \frac{k\,n_1\,e}{I_2}.$$

Now, the secondary output is

$$W_1 = E_1\,i_1\cos\phi,$$

where ϕ is the phase difference between E_1 and i_1, so that

$$\cos\phi = \frac{r}{I}$$

which gives

$$W = \frac{E_1\,i_1\,r}{I} = \left(\frac{k\,n_1\,e}{I_2}\right)^2 r$$

The internal loss in the secondary circuit is given by

$$W'_1 = i_1^2\,r_1$$

$$= \left(\frac{k\,n_1\,e}{I_2}\right)^2 r_1$$

Therefore the total secondary power is

$$W_1 + W'_1 = \left(\frac{k\,n_1\,e}{I_2}\right)^2 (r+r_1).$$

Again, the internal loss in the primary circuit is given by

$$W'_0 = i_0^2\,r_0$$

$$= \left(\frac{k\,n_0\,e}{a^2 I_2}\right)^2 r_0, \text{ approximately}$$

$$= \left(\frac{k\,n_1\,e}{I_2}\right)^2 \frac{r_0}{a^2}$$

$$= \left(\frac{k\,n_1\,e}{I_2}\right)^2 r_1, \text{ approximately}$$

since the primary coil is a times as long as the secondary, and need only have $\frac{1}{a}$ times the cross-section of the secondary coil; so that $r_0 = a^2 r_1$.

We get, therefore, for the total output, together with the losses, the expression

$$W' = W_1 + W'_1 + W'_0$$

$$= \left(\frac{k\,n_1\,e}{I_2}\right)^2 (r+2r_1).$$

We proceed now to obtain an expression for the electrical input, W_0, of the primary circuit.

Let ψ be the difference of phase between the primary current and the potential difference applied at its terminals, so that

$$\cos\psi = \frac{\text{apparent resistance of primary}}{\text{apparent impedance of primary}}$$

Now the apparent impedance of the primary circuit is given by

$$I'_0 = \frac{a^2 I_2 + a^2 I_0 I_2 Y + k I_0}{a^2 I_2 Y + k}$$

$$= \frac{a^2 I_2 + k I_0}{k}, \text{ approximately}$$

(putting $Y = 0$)

$$= \frac{a^2\sqrt{(r+r_1)^2+k^2(s+s_1)^2}+k\sqrt{r_0^2 s_0^2}}{k}.$$

Also, the apparent resistance of the primary circuit

$$= \frac{a^2(r+r_1)+k r_0}{k}$$

(seen by putting s, s_1, and s_0, each $= 0$ in the expression for the apparent primary impedance),

$$= \frac{a^2(r+r_1)+k a^2 r_1}{k}, \text{ approximately,}$$

$$= \frac{a^2}{k}(r+r_1+k r_1).$$

Hence,

$$\cos\psi = \frac{a^2(r+r_1+k r_1)}{a^2 I_2 + k I_0},$$

so that

$$W_0 = E_0\,i_0\cos\psi$$

$$= \frac{k\,n_0^2\,e^2}{a^2 I_2^2}(r+r_1+k r_1)$$

$$= \frac{k\,n_1^2\,e^2}{I_2^2}(r+r_1+k r_1)$$

$$= \frac{1}{k}\left(\frac{k\,n_1\,e}{I_2}\right)^2 (r+r_1+k r_1).$$

The mechanical output of the transformer is therefore given by

$$W = W_0 - W'$$
$$= \frac{1}{k}\left(\frac{k\, n_1\, e}{I_2}\right)^2 (1 - k)\,(r + r_1).$$

The ratio of the mechanical output to the total secondary power is

$$\frac{W}{W_1 + W'_1} = \frac{1 - k}{k}$$
$$= \frac{\text{speed of secondary circuit}}{\text{slip}}.$$

We thus get for a general alternating current transformer :—
The electrical primary input is

$$W_0 = \frac{k\, n_1^2\, e^2\,(r + r_1 + k\, r_1)}{(r + r_1)^2 + k^2\,(s + s_1)^2}$$

The mechanical output is

$$W = \frac{k\,(1 - k)\, n_1^2\, e^2\,(r + r_1)}{(r + r_1)^2 + k^2\,(s + s)^2}$$

The electrical output of the secondary is

$$W_1 = \frac{k^2\, n_1^2\, e^2\, r}{(r + r_1)^2 + k^2\,(s + s_1)^2}$$

The $i^2\, r$ losses are

$$W'_0 + W'_1 = \frac{2\, k^2\, n_1^2\, e^2\, r_1}{(r + r_1)^2 + k^2\,(s + s_1)^2}.$$

We notice that the quantities, W_1 and $W'_1 + W'_0$, that is, the secondary output and the losses are always positive ; while W and W, or the total electrical input and the mechanical output, may be positive or negative according to the value of k. This is equivalent to saying that the machine can either act as a motor or a generator.

When the secondary rotates in synchronism with the induction due to the primary, we have

$$k = 0,$$

and consequently W_0, W, and W_1 are each zero.

When the secondary rotates at any speed between synchronism and standstill, we have

k greater than 0 and less than 1.

In this case W_0, W, and W_1 are all positive, or the primary circuit consumes electrical power while the secondary circuit produces power, the electrical part of which is consumed by the internal secondary circuit, and the mechanical part is obtainable at the secondary terminals. When k lies between the limits 0 and 1, the machine therefore acts as a motor.

If k is greater than 1, the mechanical output, W, is negative, that is, the secondary circuit is driven by mechanical power : also the secondary electrical power is produced partly by the mechanical power and partly by the action of the primary, and so the machine acts simultaneously as a transformer and as an alternating current generator.

If k is negative and lies between 0 and $-\frac{r + r_1}{r}$, we have W and W_0 both negative. If $r + r_1 + k\, r_1 = 0$, the electrical input of the primary is zero, and beyond this point, that is, when k is less than $-\frac{r + r_1}{r}$, the primary electrical input becomes positive again. The machine then consumes mechanical and primary electrical power and produces secondary electrical power.

Fig. 22 is a series of curves connecting the secondary electrical output, the electrical losses, the mechanical output, and the primary electrical input respectively with the slip.

Suppose that

$$n_1\, e = 100.$$
$$r_1 = 0{\cdot}1.$$
$$s_1 = 0{\cdot}2.$$
$$r = 0{\cdot}4.$$
$$s = 0{\cdot}3.$$

The equation of the electrical output (secondary) Curve I. is—

$$W_1 = \frac{16{,}000\, k^2}{1 + k^2}.$$

That of the losses (Curve II.)

$$W'_0 + W'_1 = \frac{8{,}000\, k^2}{1 + k^2}.$$

That of the mechanical output (Curve III.)

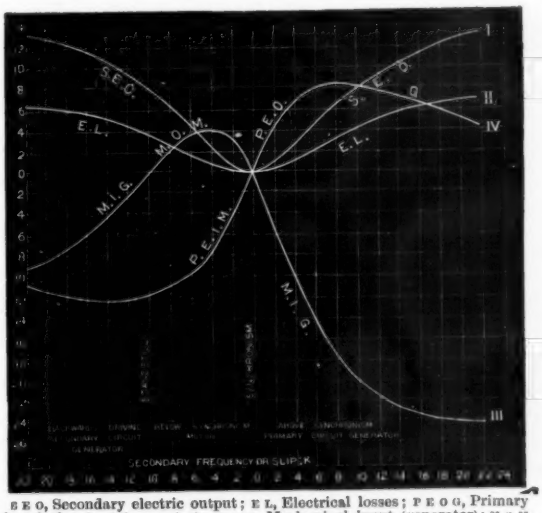
$$W = \frac{20{,}000\, k\,(1 - k)}{1 + k^2}.$$

And that of the primary electrical input (Curve IV.)

$$W_0 = \frac{4{,}000\, k + (5 + k)}{1 + k^2}.$$

Fig. 22 is taken directly from Steinmetz's paper (already quoted) and deserves careful study.

To further apply these results to the induction motor we must put $r = 0$ and $s = 0$ in the general expressions for the various powers, since the rotor coils are short-circuited, that is there is no external secondary circuit.



S E O, Secondary electric output ; E L, Electrical losses ; P E O G, Primary electrical output (generator) ; M I G, Mechanical input (generator) ; M O M, Mechanical output (motor) ; P E I M, Primary electrical input (motor).

Fig. 22.

We, therefore get, in the case of the induction motor :—
The secondary electrical output is

$$W_1 = 0.$$

The losses are

$$W'_0 + W'_1 = \frac{2\, k^2\, n_1^2\, e^2\, r_1}{r_1^2 + k^2\, s_1^2}.$$

The mechanical output is

$$W = \frac{k\,(1 - k)\, n_1^2\, e^2\, r_1}{r_1^2 + k^2\, s_1^2},$$

and the primary electrical input is

$$W_0 = \frac{k\,(1 + k)\, n_1^2\, e^2\, r_1}{r_1^2 + k^2\, s_1^2}.$$

Now the torque of the motor is the quotient of the mechanical output by the speed, and the speed is equal to $m\,(1 - k)$, where m depends only on the frequency, N, of the impressed E.M.F. and the number of poles, p. The torque T, is therefore given by

$$T = \frac{W}{m\,(1 - k)} = \frac{k\, n_1^2\, e^2\, r_1}{m\,(r_1^2 + k^2\, s_1^2)}. \qquad (8)$$

The torque, T_0, at starting is got by putting $k = 1$, therefore

$$T_0 = \frac{n_1^2\, e^2\, r_1}{m\,(r_1^2 + s_1^2)}. \qquad (9)$$

Equations (8) and (9) are of fundamental importance in the design of induction motors, for they teach us how to wind the rotor to produce the best effect.

The starting torque should be as large as possible, and the currents in both the rotor and stator should at starting not be too large.

The starting torque is a maximum for variations of the resistance of the rotor coils when

$$\frac{d\ T_0}{d\ r_1} = 0$$

that is, when $r_1 = s_1$.

Thus the *resistance* and the *reactance* of rotor coils should be equal in order to produce the maximum starting torque.

Fig. 23 is a graphical representation of equation (9), and connects the starting torque with the resistance of the rotor

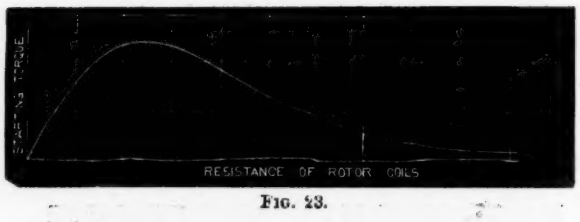


FIG. 23.

coils. The axis of resistance is an asymptote to the curve. The curve shows us that when $r_1 = 0$, the starting torque T, is zero; as the ratio of r_1 to s_1 increases, T_0 increases and reaches a maximum when $r_1 = s_1$; beyond this point, T_0 diminishes and converges to zero as the ratio of r_1 to s_1 approaches infinity.

(To be continued.)

[*Erratum.*—In the last article, page 600, line 38, for $i_0 = i'_0\, i''_0$, read $i_0 = i'_0 + i''_0$]

THE ALUMINIUM INDUSTRY.

By G. L. ADDENBROOKE.

As far as literature is concerned, the past year has been rather a quiet one. When, however, the history of the rise of the aluminium industry comes to be written, it will, as the last year has done in so many other ways, be shown to be a turning point of no mean importance. It is true there are no new inventions of importance to chronicle, no papers of much theoretical interest have appeared, except, perhaps, one by Mr. Richards, and no wonderful tales of new alloys rivalling steel in mechanical characteristics, but of one-third the weight, have astonished the simple. There has, however, been too much of this sort of thing in connection with aluminium already, which has had the effect of giving a romantic air to the industry. This has had the result of attracting to it the class who are easily led to imagine that great revolutions are to be easily brought about in the industrial world, and immense profits realised by the simplest means, and, who, when they find such is not the case, are apt to throw up everything in disgust just when, by quietly plodding on, fair results might have been attained.

Aluminium has suffered much in this way, the most extravagant pretentions have been made on its behalf, and these, on investigation, proving incorrect, inquirers have turned away in disgust, and have been led to overlook the really valuable qualities of the metal.

The failure of the Aluminium Company, of Oldbury, in which many people invested, and which, like so many industrial companies in this country, was started with far too great pretentions and far too little real knowledge of the situation, has also tended largely to prevent English capitalists, who, in this country as a rule, are extremely ignorant in all technical matters, from embarking money in enterprises connected with aluminium, although the capitalists on the continent and in America have already attained considerable success.

There is strong evidence, however, that during the last year the public appreciation of aluminium has steadily and greatly progressed, and also their knowledge of its qualities, while it is less frequently confused by otherwise instructed persons with aluminium bronze.

In order that a new metal may come into use, it is not enough that it can be procured in the form of ingots, it is most necessary that it should also be available in the form of wire, sheets, rods, tubes, and castings; the machinist must also be able to get most current sizes of each of these forms, and be able to procure castings readily to his patterns before a real start can be made on anything, except at fancy prices. Now the really essential progress which has been made during the last two or three years has been in this useful but prosaic direction.

At present the price of the metal itself, in ingots, is about 1s. 5d. per lb., while the prices of the manufactured metal are about as follows:—

Sheets, 20 B.W. gauge and over ... 1s. 10d. per lb.
Wire rod, about 20 gauge ... ... 2s. 1d. „ „
Solid drawn tubes to specification, at somewhat more than the above prices.

The above prices are for about 1 cwt. lots, smaller quantities would, of course, be rather higher in *pro rata* price, and larger quantities rather less.

As the weight of copper is 3·3 times that of aluminium and the weight of brass about 3·1 times for equal volumes, it follows that on the basis of the above prices the comparison is actually about as follows:—

Form.	Relative cost for equal volumes.	
	Aluminium.	Copper.
Ingots	5·1	4·5
Sheets	6·7	...
Wire and rod	7·5	6·0

It will, from this table, be seen that for most purposes aluminium is but little more costly than copper, and in confirmation of this it is only necessary to mention that in the price lists of some makers of culinary utensils, the prices of similar sizes of saucepans and stewpans are actually cheaper in aluminium than in copper. This may, to some, appear a small and prosaic matter, but undoubtedly great consequences will follow the fact that copper, the oldest and most important metal on which civilisation itself has arisen, is on the point of being surpassed in cheapness by another metal, extraordinarily similar in its workable and useful properties, but of less than one-third the weight.

It is pleasing also to be able to say that, in addition to its already ascertained uses, aluminium has a much better chance of becoming the electrical conductor than has, until recently, been expected.

In the spring of 1892 the electrolytic reduction of copper was coming prominently forward, and accounts of several new processes were published, chiefly, I think, from French sources, in one or two of which at any rate prospects were held out of obtaining aluminium at 4d. per pound. Now, according to the text books aluminium is a better conductor than copper, weight for weight, in the proportion of about 1 to 1·8. Consequently, if aluminium were brought down to the same price as electrolytic copper, say about 5½d. per pound, it would quickly take the place of the latter in most cases as a conductor.

It will be seen that the processes mentioned above held out hopes of aluminium being even cheaper than electrolytic copper.

The importance that such results would have in changing the conditions governing central station electric supply, led me at that time to pay considerable attention to the subject. Further investigation of the French processes did not, however, confirm the prospects held out by the inventors, though at the same time it appeared probable that the electrolytic processes might in time and when perfected and worked on a large scale, give results which would approximate those put forward by the French inventors, and which it is only fair to state comprised electrolytic reduction from the chloride instead of from the oxide, the difference being in the preliminary stages.

My investigations in this field led me to suspect that the figures for the conductivity of aluminium might not be entirely correct and further enquiry confirmed this. I could not get any information as to the purity of the samples on which the conductivity tests were based, and it occurred to

me that if these samples were not quite pure it might happen that the removal of the last traces of impurity would make several per cent. difference in the conductivity.

In order to set the matter at rest, some samples, which the makers guaranteed specially pure, were obtained from the Aluminium Company, of Oldbury, and, with the kind concurrence of Mr. Preece, a set of experiments were made on their qualities at the Post Office; Mr. Crawley also made a careful test of samples for resistance. The results showed a slightly higher conductivity than that given in the books, but relying on the representations of the makers as to the purity of the samples, I came to the conclusion that the conductivity was probably not above 60 per cent. that of copper, and all my efforts to get better samples proving fruitless I was compelled to give the matter up. In a conversation with Lord Kelvin more than a year ago, however, I referred to the matter at some length, and he seemed to think there might be something in it. During the last year I am pleased to be able to say the matter has been occupying Lord Kelvin's attention, and that the progress which has occurred in the aluminium industry since my experiments, together with the superior resources and influence which Lord Kelvin has been able to bring to bear on the problem, have enabled him to achieve what can only be characterised as a remarkable success.

Having heard lately from the British Aluminium Company that Lord Kelvin had been obtaining higher results for the conductivity of aluminium than those usually given, I wrote to him, and, in reply, received a letter which I think I shall do best to give in his own words.

The University, Glasgow,
January 11*th*, 1896.

Dear Mr. Addenbrooke,—I now find a still better result for the conductivity of pure aluminium than that which I gave Mr. Ristori nearly a year ago; and you may take 68·5 per cent. of that of pure copper as the ratio according to our present knowledge. I am in correspondence with Mr. Ristori on the subject, and it is likely I may be making further trials. If so, I shall give you the results, but meantime you may take 68·5 as representing our present knowledge.

Yours truly,
(Signed) KELVIN.

The usual conductivity, as given in the books, hitherto has been 56 per cent. that of copper, Lord Kelvin's research has, therefore, raised this by 21 per cent., so that the conductivity of a wire of pure aluminium of the same section instead of being a little over a half that of a copper wire of similar section is more than two-thirds the conductivity. Consequently the diameter of an aluminium wire of the same conductivity as a given copper wire will be only 15 per cent. greater, or less than one-sixth greater than that of the copper wire.

This is a small fraction, and it is evident that for such a small increase of diameter the extra cost of insulating aluminium conductors to the same thickness as copper ones, and to secure the same conductivity, will present no serious obstacle.

Looked at in another light, copper is about 3·3 times the weight of aluminium; on Lord Kelvin's figures the conductivity of wire of equal weights of copper and aluminium will therefore be as 100 : 22·6, so that the weight of an aluminium wire of the same conductivity as a copper one would be $\frac{1}{3}$ths of the latter, or considerably less than one half.

I do not yet know what extra cost would be entailed in manufacturing aluminium of this purity, but it may be assumed that before long the resources of metallurgy will be equal to it at a moderate cost.

As aluminium is just as pliable and easy to work as copper, it goes without saying what an advantage it would be in constructing heavy cables, and how much less strain on the insulating material it would impose. For overhead conductors for the supply of power the advantages of obtaining a conductor of equal conductivity with a trifling increase in diameter and of half the weight are also manifest.

As a conductor aluminium is now about twice as costly as copper, but as by the electrolytic process the price has already been reduced in eight years from 3s. 6d. per ounce to 1s. 5d. per pound, it is abundantly clear that with the inevitable improvements which are taking place, as the scale of manufacture is increased, and as patents expire, and competition comes in, the difference in price between aluminium and copper, which still exists, will be more than obliterated before long.

A review of the aluminium industry would not be complete without mention of the investigations of M. Moissan during the last year, on the impurities of commercial aluminium and their influence. From the writer's experience there is no subject which, at present, needs fuller elucidation, and which is likely to further more the introduction of aluminium for many purposes. M. Moissan has shown that commercial aluminium nearly always contains sodium, which is apt, if in too great quantities, to increase the action of oxygen on it. He has also called the attention of users to the deleterious effect which want of homogeneity has in aluminium containing small percentages of other metals used as alloys. The writer has also noticed effects of this class, though he is of opinion that it only needs care to obviate them.

Altogether, the last year has, if a quiet one, been an eventful one in the history of aluminium, in fact it may be said that this year marks the transition of the aluminium industry from its preliminary and experimental stage to that of a recognised and important industry. The starting of the great reduction works at Niagara in no small measure contributing to this.

CORRESPONDENCE.

Ozone and Refractory Auriferous Ores.

In the paragraph replied to by Colonel Engledue, the idea of desulphurising refractory ores by ozone was not ridiculed; I simply showed that the price of such ozonisation was prohibitive.

I would not dare criticise the gallant Colonel's opinion on fortifications, guns, attack or defence of places, but when he speaks of forcing air through an apparatus where it is submitted to the action of silent discharges and ozonised as a new invention, I am compelled to say that in 1866 or 1867, such an apparatus had already been constructed by Mr. Apps, the well known Strand optician, for either Ladd or Beanes, or perhaps for both.

It is rather premature and most assuredly bold to say of an ozone generator which has not yet been at work on a practical scale, that it is "as far ahead of the Siemens tubes (not to speak of the other known methods for the production of ozone), as the use of steam is in advance of wind as a motive power."

Has this wonderful new ozoniser been tested? What has it done? Has it oxidised oils, bleached linen, &c.? What is the quantity of ozone it produces per H.P. hour? This is what we want to know. Then we shall be able to say whether Siemens and the other ozone makers have been superseded.

Every new comer who claims that he produces cheaper ozone than the others, must have a chemical analysis made by a reliable method, and tell us how many grammes of pure ozone are generated per unit of power.

I hope Colonel Engledue will not find anything invidious in this reply. Let him try ozone on something easier than the desulphurisation of refractory auriferous ores; he will find for his ambition a field where many obstacles and difficulties of which he has no idea, would discourage a less valiant warrior.

I have not the remotest idea of running down the favourite apparatus of Colonel Engledue, which is to revolutionise the manufacture of ozone. Progress is always welcome, but it must be real progress. I will confine myself to my criticism of the desulphurisation of auriferous ores, which I call a Will o' the wisp.

I have an installation where a transformer of 3,000, 5,000, or 10,000 volts, and all the appliances for the application of ozone can be placed at the disposal of the inventor of the new ozoniser; there, in presence of experts, equal quantities (say 1 lb. or 1 oz. only) of the same pulverised refractory ore will be treated, one by ozone, and the other by the ordinary process. I have just received some rich concentrates, containing 40 ozs. of gold and 34 ozs. of silver to the ton, which will do splendidly for a test.

The ozone process will have an hour or 1½ hour's start.

I will treat the second lot in the usual metallurgical way, *i.e.*, by roasting, scarifying, and cupelling, and I will obtain the gold in the metallic state, long before the ozonised ore has been half-desulphurised.

This, I believe, would be a fair test of comparison. We want facts and not big talk.

Almost in every other case I would be a staunch supporter of ozone, but in this particular one, I am bound to say that ozone cannot be practically and profitably applied to the desulphurisation of auriferous ores dreamed of by Werdermann and others.

The Writer of the Paragraph.

Incandescent Lamp Tests.

The correspondent in your issue for January 24th, who signs himself "The Electrical Company, Limited," takes exception to Mr. Paisley's incandescent lamp test, and to some remarks I made thereon in a "communicated" article I sent you for publication last November.

As regards Mr. Paisley's figures and the method of conducting the lamp test in question, I am in no way responsible. That gentleman can, doubtless, defend both in a satisfactory manner.

In reply to your correspondent's criticisms upon my article, I would call his attention to the following facts :—

Firstly, no pecuniary interest of any kind, either for myself or others, prompted me to write the article. The only lamp concern amongst the 17 in which I am, to a small extent, pecuniarily interested, did not figure very well. I wrote the article because I was asked to do so by the editors of this journal, who, it is needless to say, did not attempt to bias me in any way.

Secondly, I am accused of not having called attention to the circumstance that the respective lamps were not run at the same efficiency, and that, therefore, the results of the test are valueless. If your correspondent will read a few of the opening sentences of my article, he will see that the circumstance of different efficiency *is* clearly and markedly pointed out, and that as a consequence the results *could not* be relied upon to indicate which were the best types of lamps. I have not the article by me or I would quote the sentence. In spite, however, of the inability of the test to furnish satisfactory information on this point, I do not regard the test as wholly valueless.

Thirdly, it is admitted that a cautionary remark is added at the conclusion of the article to warn the public from judging the quality of lamps too hastily from the trial of certain particular batches, but I cannot be held to blame if the general reader neglects to peruse and duly consider this advice.

One of the Commentators on the Test.

A Warning to Wiremen.

Now that we possess the means of photographing the *unseen*, let the wireman in future beware! By the aid of certain *x* rays, we can probe *his* joints and lay bare all their imperfections without disturbance to casings or coverings. What a field for research lies open here to Mr. Swinton and others! What revelations may not await them in this veritable peep into the regions of the *unknown!*

H. H.

BUSINESS NOTICES, &c.

Bankruptcy Proceedings.—The *London Gazette* contains notice of the release, dated December 18th, 1895, of Arthur C. Procter, of Macclesfield, trustee in *re* P. H. Pitman, carrying on business as P. Pitman & Co., at Cheadle, Cheshire, as a hydraulic, electrical and general engineer.

D. J. Whatmough, electrician, Market Place, Oldham, made an application for his discharge at the Oldham Bankruptcy Court before his honour Judge Jones, on January 23rd. The official receiver reported that the debtor had been guilty of rash and hazardous speculation. That he had not kept proper books in the business he carried on. His Honour said the debtor apparently had too many irons in the fire. He had made arrangements with his creditors in 1880, when he paid them a composition of 11s. in the £, and again in 1885 he was compelled to call his creditors together, when he paid them a dividend of 14s. 3d. in the £. Taking all the circumstances of the case into consideration he should suspend the debtor's certificate of discharge for six months.

The examination of directors in the New British Electric Installation Company was continued and closed at Worcester County Court on 22nd inst., before Sir Richard Harington.

According to notice filed in the *London Gazette*, the application of Ronald A. Scott, of Acton Hill, for discharge, will be heard at the Brentford Town Hall on February 28th, at 12 noon.

Liquidation Notices.—A general meeting of members of the English Electric Manufacturing Company is to be held at 3 o'clock p.m. on February 26th, at the office of Messrs. Owston, Dickinson & Simpson, solicitors, 23, Friar Lane, Leicester, for the purpose of having an account of the winding up laid before them.

At meetings held at Dashwood House, E.C., on December 31st, 1895, and January 16th, 1896, the members of the Merveilleuse Electric Arc Lamp Syndicate resolved that as the company cannot, by reason of its liability, continue business, it be wound up accordingly, Mr. Alfred Conder being appointed liquidator, with power to dispose of the property either for cash or to a company to be formed to work the patent rights.

According to a notice filed in the *London Gazette*, creditors of the Daimler Motor Company are required, on or before February 24th, to send their names and addresses, with particulars of their debts or claims to Messrs. Vasmer, Simms & Gray, 95, Billiter Buildings, Leadenhall Street, E.C., liquidators of the company.

A general meeting of the members of Foreign Electric Date and Time Stamp Company, Limited, will be held at the offices of Richard Warner, liquidator, 27A, Sackville-street, London, W., on March 3rd, 1896, at 12 o'clock noon, for the purpose of having an account laid before them, showing the manner in which the winding up has been conducted.

Catalogues.—From Messrs. E. M. Austin & Co., of Armley, we have received a catalogue of their "Infant Motor, Dynamo and Transformer," which has already been described in these columns. Prices, particulars, and an illustration are given.

Employés Dinner.—On Tuesday evening last a dinner was given at the Somerset Hotel, Harrogate, by Mr. C. O. Dawson, electrical engineer, of Harrogate, in commemoration, we are informed by a correspondent, of the completion of the first designs (made at his works in Union Street) of an electrical dynamo in Harrogate. Mr. Dawson intimated that he was about to bring out a new arc lamp, which would combine all the latest improvements.

For Sale.—Messrs. Wheatley Kirk, Price & Goulty are, by direction of Mr. Justice Kekewich (Chancery Division), and on behalf of D. W. Forbes and others, offering for sale by private treaty a portion of the plant and machinery, utensils, &c., on the premises known as the Smithfield Works, New Road, Blackwall, E. Further particulars will be found among our "Official Notices."

Laxton's Price Book.—The 79th edition of this annual is just published, and as usual contains a large amount of valuable information on points interesting to all concerned in building operations, in addition to the copious tables of prices which are completely revised and altered to date. A new feature in this edition is the rules of procedure in cases to be brought before the Tribunal of Appeal appointed under the London Building Act, 1894; also a new form of "Agreement and Schedule of Conditions for Building Contracts," lately issued by the Royal Institute of British Architects, which supersedes a form of "Heads of Conditions of Builders' Contract," originally agreed to between the Institute and the Builders' Society, but now withdrawn from general use. The section devoted to electric lighting occupies 31 pages.

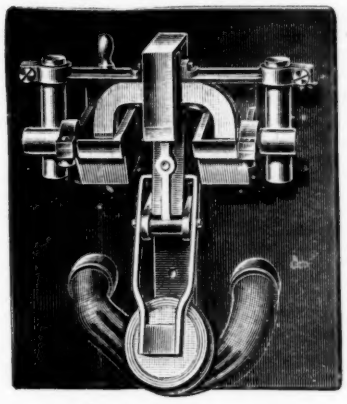
Nalder & Harrison, Limited, and Swinburne & Co., Limited.—Messrs. Swinburne & Co., Limited, announce that they have arranged to amalgamate their business with that of Nalder and Harrison Construction Syndicate, Limited, under the above title, the works being for the future combined under one roof at the Trafalgar Works, Bow Common Lane, E. The firms concerned anticipate that this arrangement will prove mutually satisfactory to themselves and their customers. Mr. Holt, late general manager of Swinburne & Co., will join the board of the amalgamated companies.

Price Lists.—Messrs. Beanland, Perkin & Co., of Leeds, have just issued (January, 1896), a price card of dynamos and electric motors as made by them. In addition to prices there is a number of columns giving other tabulated detail. Some accompanying sheets illustrate dynamos and give particulars.

Re Woodhouse & Rawson United.—Writing to the *Times* of yesterday, a correspondent, referring to the recent application in the Courts in the case of Wood *v.* Woodhouse & Rawson United, says: "As to the merits of the case (in which I am in no way interested) I know nothing, but, in the abstract, the course proposed to be taken seems to open the door to abuse if it should become a precedent. It appears that it is proposed to sell by auction to the highest bidder a claim or right to take 'misfeasance proceedings' against certain directors and auditors. If it really be in the power of a Court to adopt such a course, it seems hardly fitting that rights of action for possible breaches of duty should be made the subject of bargain and sale as if they were bad debts or household furniture. Moreover, a purchaser might, for vindictive reasons, wish to harass or crush a defendant against whom he had a grudge. He might be enabled by years of worrying litigation either to extract blackmail from the unhappy defendant or to ruin him, as in Dickens's powerful story of "The Queer Client." And this would be done with some

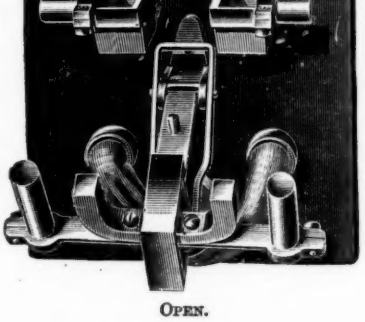
show of authorisation by the Court. The proceeding has also a somewhat Oriental flavour, and bears no slight resemblance to the farming out of taxes to the *publicani* who were the highest bidders, or to the delivery of the debtor to the tormentors for squeezing purposes."

Carbon-Break Automatic Mercury Switches (Siemens and "D. & S." Patents).—The critical balancing point of most of the automatic mercury switches at present on the market; that is to say, the point at which their movement commences, depends on the quantity of mercury in the cups, or, in other words, to the buoyancy to which the contact dippers are subjected. The depth of mercury



Closed.

is, in practice, affected by the volatilisation due to arcing on breaking circuit, and by the splashing of the contact arrangements. In the switches described, it is claimed that not only does the depth of mercury not affect the calibration point, since the axis round which the dippers revolve is immediately below, and in the same plane, as the centre of buoyancy of the mercury displaced by the dippers; but since the arcing takes place between special carbon points provided for the purpose, it is stated that very little waste of



Open.

mercury occurs. The illustrations show a maximum current cut-out in its closed and open position, and it will be seen that a very long break is provided, suitable for the high voltages used in power distribution. Any other type of maximum or minimum switch, to govern either current or potential, can be constructed on the same principle. Messrs. Dorman & Smith, we understand, have made these large enough to break 700 amperes. These cut-outs are recommended for motor circuits. There are at present 150 of them at work, with good results.

The "Rocket" Oil Engine.—This oil engine is manufactured by Messrs. Robert Stephenson & Co., Limited, under Kaselowsky's patents. There are a number of advantages claimed for it. A list before us describing the engine, claims for its simplicity, certainty in starting, regularity of movement, easy adjustment and economy. The governor, which is simple but most effective, ensures a regular speed, and this is claimed to render the engine specially applicable for electric lighting. The engines are in use in the United Kingdom, the Continent and other parts of the world, and have been applied for driving electric lighting machinery as well as a host of other purposes. The pamphlet issued by the company contains a number of recent testimonials from users. Messrs. Stephenson are also makers of electric lighting plant, boilers, pumps, locomotives, and their various departments are devoted also to shipbuilding and general engineering.

A trial of this engine was made by Prof. Wm. Robinson, A.M.I.C.E. (of Nottingham), on July 12th last year, and the following results were taken:—

Time taken to start: 10 to 15 minutes (in the open shed).

Brake Power—

Effective brake circumference	14·1	feet.
Deadweight	113	lbs.
Spring balance, mean reading	28	"
Effective load	85	"
Revolutions per minute, mean	200	
Effective horse-power	7·26	

Oil Consumption—

Total oil used per hour	6·25	lbs.
Oil per brake H.P. per hour	0·86	"
Oil per indicated H.P. per hour	0·64	"

Description of Oil used—

American petroleum; brand, Royal Daylight.

"In my opinion," says the report, "these results are exceedingly good. The governing and regularity of the speed was excellent, the speed being under perfect control of the sensitive governor."

The National Telephone Company, Limited.—This company notifies that the department for the sale outright of instruments and lines has been removed from Falcon Avenue, Aldersgate Street, to the City district offices, London Wall.

ELECTRIC LIGHTING NOTES.

Aberdeen.—The accounts of the Corporation electric lighting department for the year ended December 31st last show that the revenue amounted to £3,611 8s. 9d., and the expenditure to £1,356 18s., leaving a balance to be carried to the revenue account of £2,254 10s. 9d. From this, however, there has to be deducted for interest and depreciation £1,819 10s., so that the clear balance on the year's operations is £435 0s. 9d. The Lighting Committee is to recommend the Council to reduce the price per unit from 6d. to 5d., and the meter rents by one-half.

The Docks and Pilotage Committee of the Aberdeen Harbour Board has referred the question of lighting the quays by electricity to a committee, who are to act along with the engineer in gathering information as to the cost of electric lighting, either off the town mains or by the purchase and use of generating plant by the Harbour Commissioners.

Bradford.—Mr. Thomas Barker, architect and engineer, of Bradford, has been appointed to superintend the new electricity works at Frizinghall, the plans, &c., to be prepared in the office of the Bradford borough surveyor. Tenders for dynamos suitable for high-pressure engines have been accepted from Messrs. Siemens Bros., of London.

Brighton.—The electric light was a few days since turned on in the council chamber. There are three silver-gilt electroliers, one having 20 pendant lights arranged in a double circle and the other two single circles of 10 lights each.

Barmouth.—The District Council, on 22nd inst., passed a resolution approving of the application of the Barmouth and District Electric Lighting and Power Company for a provisional order, but the matter is to come up again, for a member intends moving that the whole question of electric lighting be considered.

Brechin.—The Brechin Paper Mill is now lighted by electricity. The plant comprises an 8-H.P. Shanks engine, a dynamo, and 110 incandescent lamps. Messrs. Lowden Bros., of Dundee, carried out the work.

Cardiff.—Four fitters employed by the Corporation in the Electricity Department having made a statement to the effect that there are certain defects in the engines and boilers at the station so as to afford ground for considerable anxiety, the Corporation has engaged an expert to investigate the matter and report.

Dover.—Upon the recommendation of the Lighting Committee the council is requesting the Electricity Supply Company to alter the positions of a number of electric light pillars.

Dundee.—There was a mishap at the central station on 21st inst., occasioning a failure in the private supply.

Edinburgh.—The contemplated extension of the system in the city was under consideration by the Electric Lighting Committee on Tuesday, and authority was given for the acceptance of offers for boilers, super-heaters, mechanical stokers, steam dynamos, and other appliances, at a total estimated cost of over £20,000. It was resolved to recommend the Magistrates and Council to oppose the petition to the Privy Council by Dr. Hopkinson and the Westinghouse Company, praying that the three-wire system patent, which expires in July next, should be extended for a further term of years.

Eccles.—The Eccles Property Owners' Association has resolved to issue a reply to the pamphlet recently distributed to the ratepayers on the proposed electric light installation, and 6,000 copies are to be printed and circulated.

Electric Light in Torpedo Destroyers.—Before joining their respective squadrons the recently-commissioned torpedo boat destroyers were fitted with temporary gear for electrically lighting their engine rooms and boiler rooms. Orders have been received at Devonport to take the *Lynx* in hand for the same purpose, but in her case the fittings throughout will be of a permanent character. Ten incandescent lamps will be distributed in each of her two boiler rooms, and 10 in her engine rooms.

Finland.—Electric lighting is being adopted on the railway carriages on the Finnish railways.

Glasgow.—The Committee of the Police Department on Electric Lighting have appointed Messrs. Primrose, Guthrie, and Cleland, to visit Edinburgh and inspect the system of electric lighting of the city on the invitation of Lord Provost M'Donald.

Haverhill.—The electric light has been recently installed in the mat and matting department at Chauntry Mills.

Islington.—The Vestry give notice that on and after 31st inst. (to-day) a supply of electricity will be available from the mains now laid in certain streets stated in their announcement.

Ipswich.—The Council has decided to oppose the granting of a provisional order to the County of London and Brush Company, and has considered a report obtained from Prof. Kennedy on the subject of electric lighting. The committee has been empowered to again consult Prof. Kennedy regarding his "alternative scheme" of £18,000.

Llandrindod Wells.—The District Council has accepted a proposal for street lighting by electricity for the next seven years, at an annual charge per lamp of 58s. 6d. (including cost of renewals and repairs) for 70 lamps of 32 C.P. each. The light is expected to be ready by August next.

Much Woolton.—The Works Committee raise several objections to clauses, &c., in the provisional order sought by the Liverpool District Lighting Company for electric lighting, and are forwarding them to the company.

Portsea.—The Hospital and Imbecile blocks are to be lighted by electricity, at an estimated cost to the Guardians of £250.

Portsmouth.—The Council has resolved to light Goldsmith's Avenue by electricity. The cost of mains, lamps, and the necessary work, is estimated at £1,500.

Preston.—A proposal to extend the street arc lighting was to come before the Council yesterday.

Richmond.—We hear that the new Free Church which has just been erected in Ormond Road, Richmond, Surrey, will be electrically lit throughout. The number of lamps will be equivalent to over 100 of 16 C.P., and Mr. Hemingway is to do the work.

Southampton.—The Southampton Electric Light and Power Company anxious not to lose the custom of the Pier and Harbour Board, who contemplate laying down their own plant, have offered to supply at a reduced rate. No notice is to be taken of their communication.

Southport.—The chairman of the council at the last meeting said that the net result of the year's working would provide for a dividend of 4 per cent., leaving £50 to carry forward if the concern had been in the hands of a company. £4,000 more is to be borrowed for extensions.

St. Pancras.—In a recent issue we stated that the St. Pancras Vestry had resolved to reduce the supply to churches and chapels to 3d. per unit. This, Mr. A. E. Pycraft informs us should read 5d. per unit.

Swansea.—A local government board inquiry into the application to borrow £60,000 for the Corporation triple scheme, was held last week.

Worcester.—A sub-committee has been appointed to consider the advisability of extending the electric street lighting. The mover of a resolution thought the present arc lamps are closer together than is necessary.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Councils Oppose.—The Fenton, Stoke, Burslem, and Turnstall Councils are raising objections to the applications of the promoters of the electrical tramway provisional order.

Electric Traction in Belgium.—Tenders were recently invited by the Société Nationale des Chemins de Fer Picinaux, of Brussels, for converting its steam local railways in the centre district of Belgium into electric lines. Offers were received from the leading Belgian and several German electrical engineering firms, but the company has decided to re-invite tenders, as none of the former ones entirely conformed to the specifications laid down. Plans are in course of preparation for the conversion of the horse tramway in Brussels, between the Bois de la Cambre and Schaerbeck, into an electric line on the conduit system.

Electrical Engineering in Austria.—An electrically-operated locomotive turntable is being constructed at the works of the Simmering Waggon Company, at Simmering, near Vienna, for the Austrian State Railways.

Electric Traction in Germany.—The Hanover Tramways Company is preparing plans for the construction of an electric tramway between Hanover and Hildesheim. The construction of a series of electric tramways in the Oberhausen, Styrum, and Mulheim districts of the Ruhr, is under contemplation. Messrs. Siemens and Halske, of Berlin, are interested in the matter. A sum of £2,500 has, it is stated, been voted by the municipal authorities of Berlin for the purpose of experiments as to the best method of traction on tramways—steam, electric, or gas. Negotiations have been in hand for some time between the Union Electrical Engineering Company, of Berlin, and the Königsberg tramways authorities with reference to the conversion of the horse tramways into electric lines, but the scheme is reported to have fallen through.

Halifax Tramways.—A largely attended town's meeting over which the Mayor presided, resolved, on 24th inst., by a considerable majority that the question of tramways for the borough had better be deferred. The company, which is promoting a bill in Parliament for the construction of tramways at Halifax, has offered to lease the Huddersfield lines from the Corporation, and proposes a very extensive scheme to cover not only the towns named, but surrounding districts.

Isle of Man Tramways.—We understand that a London syndicate have had surveys made for the construction of a line of electric railway from Laxey to Ramsey. The terminus of the Douglas and Isle of Man Electric Tramways Company's system is at Laxey.

Light Railways.—The recent conference on light railways, held in London, it will be remembered resulted in the appointment of a committee to examine the report of the Board of Trade committee on the subject and the Bill of the late Government, and to make recommendations. The committee met on 24th inst. at Westminster Palace Hotel, Sir Albert Rollit, M.P., presiding. It was reported that Mr. Ritchie had consented to receive a deputation on the subject, and the committee appointed a sub-committee as the deputation.

Leeds Tramways.—Dr. Hopkinson's report and recommendations came before the Highways Committee, and, after discussion, it was decided, subject to the approval of the Council, that the recommendations for the construction of an electrical tramway from Kirkstall to Roundhay, with the Westinghouse closed conduit system in Boar Lane, be adopted, subject to such modifications of detail as the committee afterwards deem advisable.

The Metropolitan Railway and Electricity.—We give the following on the authority of the *Daily Telegraph*:—Travellers by the Underground Railway will hail with satisfaction an announcement made by Sir Edward Watkin at the half-yearly meeting of the Metropolitan Company. The directors, he said, desired to improve the ventilation of their line, and to this end had always wished to substitute electricity for the steam traction now in use. But hitherto there had been no scheme whereby heavy trains could be moved by electric power, except at greatly increased cost. Arrangements, however, had now been made which might soon overcome all difficulties. Certainly patrons of the line will not be slow to congratulate them in the event of success rewarding their efforts.

TELEGRAPH AND TELEPHONE NOTES.

Cable Repair.—The Dover *Standard* says that H.M. telegraph ship, *Alert*, left Dover Harbour on Monday, 20th inst., for the Kentish Knock to repair the cable.

Dover Telephones.—The relationship between the National Telephone Company and some prominent members of the Corporation is not of the happiest just now, and there is the probability of the Corporation seeking powers to establish a local municipal exchange.

Interruptions and Repairs.—The St. Thomé-Loanda cable was repaired on Monday, but the Aden and Zanzibar cable was again interrupted the same day, all telegrams for the South and East Coast of Africa having to be sent by the West Coast route.

Politics and Telegraph Cables.—A political map of Africa, which the *Graphic* published last week as a supplement, intended to be very correct in every detail, including submarine telegraph cables, left out entirely those between St. Paul de Loanda and Cape Town, making South Africa dependent for communication with the rest of the world on the East Coast cables. This is not a very creditable piece of work, considering what prominence the African cables have attained of late. It is surprising how frequently one sees telegraph cables wrongly plotted or omitted altogether. Only the other day we noticed in a London shop window a map of the Guianas, of quite recent publication, in which a cable is shown as running between Demerara and Surinam in Dutch Guiana when none exists, and the French company's cable from Martinique to Surinam is omitted.

Telegraphs in Turkey.—A commission has been appointed by the Turkish Telegraph Department to enquire into the improvement of the telegraph services in the Provinces of Angora, Adrianople, and Salonica.

CONTRACTS OPEN AND CLOSED.

OPEN.

Austria.—March 1st. The Municipal Authorities of Brünn are inviting tenders for the establishment of a central station in the town for the generation and supply of electrical energy for lighting and power purposes, including that necessary for an electric tramway. Tenders to be sent to the Burgermeisteramt der Landeshauprstadt, Brünn, Austria.

Canary Islands.—February 29th. Tenders are being invited for the 35 years' concession for the electric lighting of Sainte Croix de Teneriffe, Canary Islands. Tenders to be directed to the Ministère de la Gobernacion in Madrid, Spain.

Eston.—May 1st. The District Council invites schemes for lighting the district by electricity, such schemes to embrace (*a*) plan and estimated cost; (*b*) annual working cost and maintenance. Particulars from the District Surveyor, Grangetown, Yorkshire.

France.—February 13th. The General Direction of the French Posts and Telegraphs is inviting tenders for the supply of 500 tons of galvanised iron telegraph wire in five lots. Tenders to be directed to the Direction Générale des Postes et des Telegraphes, Rue de Grenelle, 103, Paris.

Huddersfield.—February 4th. The Electric Lighting Committee invites tenders for the supply of two steam boilers, four mechanical stokers, and one surface condenser, with air and circulating pumps. Details to be obtained from Mr. A. B. Mountain, borough electrical engineer, St. Andrew's Road, Huddersfield.

Italy.—February 28th. Tenders are being invited by the Municipal Authorities of Parma, an important old town about 60 miles from Milan, for the concession for the electric lighting of the public streets for a period of 15 years, commencing June, 1897.

NORTHERN SOCIETY OF ELECTRICAL ENGINEERS.

THE third annual dinner of this flourishing young society was held at the Grand Hotel, Manchester, on Friday evening of last week. About 60 sat down to an elegant repast, well served, after which geniality and friendship enabled the members and their friends to enjoy an evening of unalloyed pleasure. Mr. W. P. J. FAWCUS, the President, gave the usual loyal toast, saying: The first toast which it is my duty to propose this evening is one which, under ordinary circumstances, is greeted with enthusiasm by every loyal Englishman, it is that of Her Most Gracious Majesty the Queen, but to-night there are circumstances which make this toast of even greater importance than usual. During the last few weeks this country has been threatened with serious danger from many quarters, and although there are prospects of this danger passing, it is by no means over yet. England menaced by the envy and hatred of the most powerful nations is standing almost alone. At such a time it is satisfactory to see the manner in which Englishmen are prepared to support their Sovereign in the defence of their country. Dr. John Hopkinson, whom we had hoped to have with us this evening, addressing the Institution of Electrical Engineers in London last week, indicated the movement that is on foot at the present time among the electrical engineers of this country to be prepared to offer their services, should they be required, in defence of the country, as it is considered that their knowledge will be very valuable in modern warfare. I understand that it is not intended that the movement should result in the formation of an ordinary rifle corps, but in a separate service their special knowledge could be utilised in case of national emergency. I feel confident that in this movement we, in the North, will be prepared to co-operate most heartily with our London friends. The north has never in the past been behind the south in loyalty, and I hope may never be so. It is my intention, at the next general meeting of the Society, to bring this matter up, in order that we may discuss in what manner we can associate ourselves with the movement. There is another reason why we should drink this toast to-night with sincerity: at the present time Her Majesty is suffering a bereavement in which she has the sympathy of the nation, her son-in-law, Prince Henry of Battenberg, having fallen a victim to the terrible fever so prevalent on the East Coast of Africa, while he was engaged in the service of the country. I therefore call upon you, gentlemen, to drink the health of the Queen.

Mr. EDMUNDS, retiring president, next proposed the toast of "The President," referring in complimentary terms to the good work which had been done for the N.S.E.E. by the President, W. P. James Fawcus, who had been an active member since the formation of the Society, constant in his attendance at the meetings, stimulating all by his geniality and good common sense. Mr. Edmunds also referred to the fact that the Society had increased beyond expectation, that it had achieved most useful work in the past, and would, doubtless, continue to do even better under the able presidency of Mr. Fawcus. He also referred to the fact that the Society was calculated to bring about a better feeling amongst members of the profession and electrical trades generally, because all could meet on a common footing, and by becoming better acquainted, could better appreciate the sterling qualities of the various sections of the electrical industry. He introduced the question of a volunteer regiment formed from the members of the electrical profession, and strongly urged all members to support the idea of a corps being formed and designated in some special manner which would indicate that it sprung from the electrical industry. The idea was taken up with great enthusiasm, and on a show of hands not a single dissentient was found, so that we may shortly look for an addition to the defences of the country through the members of the N.S.E.E.

Mr. FAWCUS responded.

Mr. C. M. DORMAN, in submitting the toast of the "Past President," said he felt like an artilleryman, who had only to pull a string to cause an immense amount of latent energy of enthusiasm to change from a potential to a kinetic state. Being very young, they could hardly be a Society "with a past;" but, at any rate, they could boast of a Past President. They owed Mr. Edmunds a great debt of gratitude for the dignified, yet happy and genial manner in which he had presided over the meetings of the Society during the past year. On many occasions he had travelled from London purposely to attend their meetings. He (Mr. Dorman) did not know the exact dimensions as regarded mass, length, and time, of the absolute unit of gratitude; but the practical unit used by the Northern Society in this instance ought to have a positive index and a large one. It was very gratifying to them to remember that during his year of office, their late President had been elected a member of Council of the Institution, an honour which they, as members of the Northern Society, could not help feeling reflected in some small measure on themselves.

Mr. EDMUNDS having replied,

Mr. S. V. CLIREHUGH followed with the toast of "The Guests," coupling with it the names of Mr. Holden, President of the Manchester Society of Architects, Mr. H. Alabaster of the ELECTRICAL REVIEW, and Mr. W. L. Madgen, of *Lightning*. These gentlemen having suitably responded,

Mr. ALABASTER proposed the toast of "The Society," to which Mr. BROWETT replied, concluding by proposing the toast of "The Committee."

Songs and recitations by Messrs. Marr, Pope, and other gentlemen, enlivened the festivities which were continued into the small hours of the morning, the company at last separating with evident regret that such successful gatherings cannot be prolonged indefinitely.

NOTES.

The Queensland Vacancy.—The Government of Queensland have certainly taken a step in the right direction by advertising that they are prepared to receive applications for the post of electrical engineer to the Government. We wish they had gone a step further and made it a condition that such engineer is to devote his services exclusively to Government work, and absolutely abstain from private practice. It is pretty generally recognised that an engineer in such a position, who is required to give disinterested advice, should certainly not be mixed up himself in anything, to say nothing of the unfairness of an official receiving a salary of £600 entering into competition with other engineers who may have neither this income nor the standing which naturally goes with such an appointment.

The Reese Reinforced Copper Pipe for High Pressures.—Modern electric central station work is approaching more and more to marine practice; this refers, says a trans-Atlantic exchange, not only to the adoption of vertical compound engines direct connected to the generators, but to other details, such as the increase in steam pressure and the adoption of devices made necessary in consequence. For connecting the engines with the main steam lines, the best practice now requires the use of copper pipe, but in order to retain its flexibility and still maintain its proper strength, some reinforcing device is required. Messrs. Thomas Reese, Jun. & Co., of New York, have devoted special attention to this class of work. This firm furnished all the spiral copper banded pipe used in the Twenty-sixth, Thirty-ninth, and Elm Street stations of the New York Edison Company. A 16-inch main used in the Edison station consists of a pipe of No. 00000 B.W.G. gauge, around which is wound spirally a band of copper 2 inches × ¼-inch in section, and to ensure uniformity of strain transmission, the spiral band is brazed to the copper pipe. A special device is employed for making the joint. For this purpose the end of the main pipe carries a heavy copper angle flanged out of solid plate. Seated on this flange is a loose steel ring rolled from a solid forging, in the same manner that locomotive tyres are made. This steel ring is drilled for the insertion of bolts for tightening the joint which is made between the copper flanges. The same firm also furnished the exhaust pipe and the main smoke flue in the Duane Street Edison station. The former is 32 inches in diameter, and made of $\frac{5}{16}$-inch steel with copper angles and loose steel rings similar to those of the high pressure steam pipe described above. The main smoke flue is built of ½ inch steel plate, and is so arranged that the air circulates around it, and absorbs heat before entering the furnaces under the boilers.

The Hampstead Fatality.—Dr. G. Danford Thomas held an inquest at the Hampstead Dispensary Hall last Saturday on the body of Edwin Clarkson, aged 36, an electrician, in the employ of Messrs. Siemens Brothers, and lately residing at Sun Street, Woolwich, who met with a shocking death on 21st inst. whilst at work at the Hampstead Vestry's central electric lighting station. The Hampstead Vestry was represented by Mr. A. P. Johnson, Vestry Clerk, and Mr. G. H. Cottam, chief electrical engineer, and several members of the Vestry were present. Mr. A. J. Cameron, of the Home Office, Her Majesty's Inspector of Factories, also attended. Mr. G. H. Cottam, who was one of the witnesses, said he believed that the deceased was upset that day because he had lost some money. The current was not on the wire which he had to disconnect, but it was on an adjacent one, and whilst doing the work he probably handled that wire, at the same touching an adjoining terminal with the elbow of his other arm. In this way he probably received the shock which caused his death. The jury returned a verdict of accidental death, and suggested that the workmen should be compelled to wear gloves when engaged in any dangerous electrical work.

Obituary.—We regret to notice the announcement of the death, on January 23rd ult., of typhoid fever, at the early age of 23 years, of Mr. Thomas Ernest Manson Rymer-Jones. For several years Mr. Rymer-Jones had been on the submarine telegraph staff of the Silvertown Company, and during his connection with that firm had gained the entire respect and confidence of his chiefs by his assiduity, carefulness, and unflagging interest in his duties; in moments of difficulty or danger, his courage and quick perception were always to be relied upon. Apart from those qualities which distinguished him in his work, his kindly disposition, his never-failing cheerfulness, and his fondness for and proficiency at all manly sports, endeared him to his colleagues and companions. We tender our respectful sympathies to his family in their bereavement, and we join with the members of the Silvertown staff in regretting the loss of one so highly esteemed by all who knew him.

A Big Traction Scheme for London.—We are given to understand that an electric traction scheme of considerable dimensions for London is likely to be taken in hand shortly. The necessary preliminary arrangements are in progress at the moment.

A Severe Storm.—The *Philadelphia Record* states that a most remarkable electrical storm occurred at sea early in December last, off the Grand Banks of Newfoundland, and the effects were experienced by the British ss. *Mercedes*, which was carrying a cargo of iron ore. It is stated that on the nights of December 3rd and 4th, the ocean appeared like a mighty mass of flames or an endless stretch of prairie fires. Balls of electric fire hissed and exploded in all directions, and darted among the vessel's masts and rigging. The *Mercedes* was struck by a south-southwest gale, which was accompanied by seas rolling fearfully high. During the height of the storm a huge deck derrick, weighing many tons, was torn loose from its fastenings and swept overboard, leaving a hole in the vessel's deck through which the water ran into the cargo. In its course it carried away the main topmast, which was also of iron, part of the flying bridge, the after winch, and part of the deck fittings. The decks were flooded with tons of water, the ship rolled at an angle of 70°, and the sea broke in all directions, filling the cabin and the officers' quarters. Soon afterward the storm partially subsided, when the electrical fire appeared in all directions. It hung in big balls for two nights from the masts and fore and aft stays, and practically turned night into day. As the big fire balls came together they would burst with a loud report upon the vessel, and disappear. Under this light at night such temporary repairs were made as were deemed necessary to reach port. Captain Tait, of the *Mercedes*, stated that the passage was one of the most trying experiences of his life.

Electrical Installation Company v. Francis.—In the Westminster County Court yesterday, this case came before his Honour Judge Lumley Smith, Q.C., being a claim for £6. Defendant contracted to supply certain lamps, a total of 238, for fitting at a London hospital. When they were delivered, it was found they were short to the number of 74, and application was made, but the defendant denied there was an error in the number charged and paid for. The defence was that the full number of lamps were delivered, and after the complaint of the non-delivery, the plaintiffs paid for them all. Judgment was given for the plaintiffs for the amount claimed.

Severe Storm in Canada.—During the late storm in Canada the telegraph wires were down in every direction. In Toronto itself the sleet and wind broke down the telegraph, telephone, and trolley wires in all parts of the city, causing an almost complete stoppage of street traffic owing to the danger caused by the broken wires. Two men and several horses are said to have been killed by contact with live wires. The storm is the worst that has been experienced there for several years, and the damage to property is very great. On 24th inst. the city was in darkness, all the electric lights being out.

Resignation of Mr. Monkhouse.—Mr. E. W. Monkhouse, the resident electrical engineer at the Edinburgh Corporation electric lighting works, has resigned his position there, the resignation to take effect from April 30th. It is his intention to start in business as a consulting engineer in London. The Electric Lighting Committee is to advertise for applications for the vacancy thus caused.

Premiums Offered.—Two premiums, valued at £15 and £10 respectively, are being offered by the Bavarian Industrial Museumtauthorities for a practical electro-motor of from ⅛ to ¼ H.P., suitable for domestic use, and also in hand industries. Models, &c., are to be sent to the Bayerische Gewerbe Museum, in Nuremburg, by July 1st next.

Cricket Fixtures.—The cricket section of the "Byng" Athletic Club (General Electric Company, Limited), has a number of open dates for Saturdays for the ensuing season, and would like to hear from other trade houses, with a view to arranging matches together, they being a weak, medium team.

Photographing the Unseen.—Before the Physical Society, last Friday, January 24th, Mr. Campbell Swinton exhibited some photographs which he had taken by Prof. Röntgen's method. These included several of metal objects inside wooden and cardboard boxes, and a photograph of the bones of the hand, such as we reproduced last week.

Mr. Lawson Walton For and Against :—

Mr. Lawson Walton, Q.C., appeared for us against Dr. Tibbitts in February, 1893, and made us blush by saying :—

"Mr. Alabaster and Mr. Gatehouse, and Mr. Kempe, founded the ELECTRICAL REVIEW. . . . They were all scientific men, and Mr. Gatehouse and Mr. Kempe, who were specially responsible for the article which was impugned, were men of some eminence in a profession which involved a knowledge of electricity. They . . . were men who could form an opinion of some weight."

Mr. Lawson Walton appeared against us in the Hall case, and said :—

"The defendants were a trade journal, and their news columns were largely devoted to describing the machines and operations which they advertised."

Fraser v. South.—In the Westminster County Court this case came before His Honour Judge Lumley Smith, Q.C., and was a claim for £13 for two stage arc lamps supplied on approval to the defendant, an electrical engineer, of Garrick Street. The plaintiff's case was, that in November last he let defendant have the lamps on approval, and when a month elapsed, and they were not returned, he charged for them, but no notice was taken either of the inquiry as to whether he was going to take them or return them. The defence was that Mr. South had them to fix at the Tivoli Music Hall, the plaintiff's late partner having offered the manager of the hall the opportunity of trying them. His Honour thought they had been kept too long, and gave judgment for the plaintiff for the amount claimed, with costs.

"Autocars."—One of the latest magisterial decisions, that horseless vehicles are locomotives under the Locomotive Acts, has been given by Police Judge Mitchell at the Glasgow Central Police Court, who has fined George Johnston, the inventor of a horseless carriage, the nominal sum of 2s. 6d., for propelling it along the public roads during prohibited hours. Mr. Johnston asked, as a matter of principle, that a case be stated for the High Court. Another similar decision, with a heavier fine, has been decided at Tunbridge Wells.

The X Rays Foreshadowed.—In last week's *Nature* a letter appeared from Dr. Bottomley referring to some scientific papers of Lord Kelvin written some years ago, in which the x rays of Prof. Röntgen are very clearly foreshadowed. To everybody who takes an interest in photographing the unseen, we would recommend a perusal of Dr. Bottomley's letter.

Lectures on Transformers.—Prof. J. A. Fleming delivered his second Cantor lecture on "Alternate Current Transformers" on Monday last before the Society of Arts. He dealt chiefly with the practical construction of the transformer. His third lecture, to be given on Monday next, will be devoted to the testing of transformers.

Better Utilisation of Central Stations.—In our January 17th issue, the article by Dr. Rasch on this subject was credited to *L'Industrie Électrique*. We find, however, that the article first appeared in the *Electrotechnischen Zeitschrift* for November 21st, 1895, and was afterwards published in the French contemporary.

Vibration.—The *St. James's Gazette* says the vibration caused by electricity, steam trams, &c., is seriously affecting the stability of the buildings in Paris, and has already resulted in the fall of a statute from the Grand Opera House, where the chandeliers move so much as to disturb the performance by their jangling.

Lectures.—In connection with the Ford Wesleyan Church on 21st inst., Mr. T. W. Martin lectured on "Telegraphs and Telephones."

Mr. Wm. Bannister lectured at Foleshill on Monday on "Glimpses of Electricity."

Presentation.—Mr. Arthur Langdale, electrical engineer to the Telegraph Department of the Post Office at Middlesborough, was presented with a case of cutlery on the occasion of his removal to the Northallerton district.

Sir John Pender.—The latest report regarding Sir John Pender is that he remains in a very grave condition.

CITY NOTES.

City and South London Railway.

THE twenty-third ordinary general meeting of the proprietors of the above company was held on Tuesday at Winchester House, Old Broad Street, Mr. C. G. Mott presiding.

The report and accounts having been taken as read, the CHAIRMAN, in proposing their adoption, said he was glad to again be able to report that they had carried over 3,000,000 of people with perfect safety, and with almost absolute punctuality during the half-year. There had been a decrease in the number of passengers as compared with the corresponding half-year of 1894, of 103,000, but an increase over the June half of about 60,000. The decrease was explained by two or three reasons. The first was that about a year ago they increased the fares, in order to diminish the overcrowding on the railway, which had a very decided effect in decreasing their numbers. Then during the first three months of the half-year exceptionally fine weather prevailed, which naturally had a prejudicial effect upon their traffic. The decrease at that time led the directors to consider the question of revising the fares, and they lowered them at one of the stations down to their old level. The result was that they immediately obtained an increase in the passengers, which compensated them for the losses they had in the previous quarter, and resulted in their having a decrease of only £50 in passenger traffic, other than season ticket holders. Fortunately, the season tickets showed an increase of 62 in numbers, and of £290 in receipts, as against the corresponding period last year. That gave them a net increase in their passenger receipts of £240 on the half-year. As he had said, the increase of their fares had led to a somewhat diminished traffic, but they had already partially recovered that decrease, and he hoped that in the present half-year they would show a decided increase both in numbers carried and in receipts. At the same time, the overcrowding of the trains was going on again, and to meet it they had made an alteration at their King William Street Station. It had proved a very difficult piece of work, but it had been completed, and they now had two trains at once in the station, as at Stockwell, so that passengers had not to wait for a train. They were now enabled to run several additional trains in the hour, and he hoped that when the appliances were in thoroughly good working order, the increase would be still further. That would enable them to diminish the overcrowding, and to give better accommodation for the passengers in the morning. Unfortunately, at the present moment they had often to turn away a large number of passengers, for the present arrangement was only a temporary one, and they felt that the time had now arrived when they could no longer delay proceeding with the additional accommodation which they intended providing, to enable them to deal with the increased traffic. They had been very careful and cautious in going on with the work—perhaps a little too cautious—and it was evident that no time must now be lost in proceeding with the extensions. They therefore intended to ask the shareholders to authorise them to proceed at once with that portion of the extension as far as Finsbury Pavement. To meet the additional trains which they were now beginning to run, they had ordered new carriages which had all been delivered, and they appeared to give general satisfaction. They had turned their attention to see if they could possibly reduce the working of the line still further, and they had introduced a small engine and dynamo in the engine house, which saved them using a large quantity of current at periods of the day when the traffic was not heavy. They were also about to erect a large condensing apparatus at Stockwell, which they estimated would save them a considerable amount of fuel. The condenser was now being made, and he hoped would be fitted up before the summer. The new sidings at Stockwell were completed, and were just being brought into use. He quite realised that they could not make the line a success until they had got the extension carried out, so as to enable them to carry the traffic which was ready for them. On capital account they had paid off £9,400 terminable debentures, and they had expended on new carriages, engines, &c., £6,683, making a total payment of £16,083. To enable them to do that, they had issued preference shares to the amount of £4,690, on which they had received in premiums £2,237. Turning to the revenue account, the receipts from passengers had increased by £240, parcels £39, rents £105. On the other hand there had been a decrease in receipts of £302. Maintenance expenses showed a reduction of £65; locomotive expenses of £85, traffic expenses of £50, general expenses of £42, law charges £17, and rates and taxes £9. On the other hand there had been an increase in the carriage repairs of £97, and in the passenger duty of £47, making a net decrease in the expenses of £124. The final result was that they were better for the half-year by £673, which was very nearly equal to an increased dividend of ¾ per cent. It might naturally be asked why the directors had not proposed an increased dividend; but when the last dividend was paid, they had the advantage of £417, which had been carried over from the previous half-year. They had not got that balance this year, and so they proposed to pay the same dividend, and carry the balance forward. The working expenses for the half-year had been 59·62 per cent. against 60·9, and if they took off the cost of the lifts, the ratio was 51¼ per cent. as against 52. The receipts per train mile had been 2s. 2d. against 2s. 1¼d., and the receipts per passenger had been 1·80d. against 1·77d. Locomotive expenses per train mile had been 6·02 as against 6·03. He was glad to say that they had made satisfactory arrangements as regarded the sites of the stations for their extension, and they felt pretty certain that they would be able to carry out the work at their original estimate of £280,000. Considering the length it would be a very cheap line if carried out for that sum, and considering that it would go through some of the busiest streets in the world, he had no doubt that in addition to paying the preference interest, there would be a large surplus to increase the dividend on

the ordinary stock. He was sorry to say that the company had lost the services of its engineer, Mr. Basil Mott, who had been with them since the line was first made. While sorry to lose him, they were glad that he left them to take up more important work in connection with the great Central London Railway, and they wished him every success in his new sphere. During the whole time that he had been engineer, he had had under him a very able assistant in Mr. McMahon, and, acting in the best interests of the company, they had appointed that gentleman to succeed Mr. Mott as engineer.

Mr. SAMPSON HANBURY seconded the adoption of the report, and the motion was carried without comment.

The retiring directors and auditors having been re-elected, the meeting was made an extraordinary one, when the CHAIRMAN proposed a resolution for the creation of 55,000 new ordinary shares of £10 each, and 20,000 preference shares of a like amount, the latter to bear interest at the rate of 5 per cent. per annum. He explained that it merely created the capital, and did not give the directors power to spend it without first obtaining the approval of the shareholders. The preference shares would, he said, be issued at a premium, so that the company would really pay about 3½ per cent., and not 5 per cent. interest.

Mr. BARCLAY HEWARD seconded the motion.

Mr. THOMAS HANBURY moved an amendment to the effect that the proposed issue of preference shares would be unjust to the ordinary shareholders, and that therefore it be not authorised.

Mr. MIDDLETON seconded, but upon being put to the vote the amendment only received two votes, and the resolution was thereupon carried.

A resolution was also carried approving of a Bill now before Parliament, intituled:—"A Bill to extend the time for the purchase of lands for the purposes of the City and South London Railway Act, 1893, and for the completion of the Underground Railway and Works thereby authorised, and to empower the Company to acquire additional Lands, and for other purposes."

A vote of thanks to the chairman for presiding closed the proceedings.

The Yorkshire House-to-House Electricity Company, Limited.

THE report of the directors to be presented to the ordinary general meeting of the company, to be held at the registered offices of the company, Central Electric Lighting Station, Whitehall Road, Leeds, on Tuesday, the fourth day of February, 1896, at half-past two o'clock in the afternoon, states that the profit for the year (including £162 1s. 9d. brought forward from the previous year) amounts to £6,483 3s. 11d., which the directors propose shall be appropriated as follows:—

To Reserve: For general purposes ...		£2,000	0 0
„ Reserve: For depreciation		1,300	0 0
„ Payment of interim dividend at the rate of 4 per cent. per annum upon the ordinary shares of the company, numbered 101 to 10,100 inclusive, made for the half-year ending June 30th, 1895	£1,000 0		
„ Payment of final dividend at the rate of 6 per cent. per annum on the same shares, for the half-year ending December 31st, 1895, making 5 per cent. for the year ...	1,500 0		
		2,500	0 0
„ Payment of a dividend at the rate of 5 per cent. per annum on shares numbered 10,101 to 18,948 inclusive, on the amount called and paid up thereon from the respective times of payment, to December 31st, 1895 ...		165	7 7
„ Balance to carry forward to next account ...		517	16 4
		£6,483	3 11

The works and plant of the company have been maintained in an efficient state, and the quality of the supply of electrical energy continues to give satisfaction. The number of lamps connected to the mains increased during the year from the equivalent of 19,858, to the equivalent of 32,539 35-watt lamps. A reduced scale of charges for current, at a maximum price of 6d. per Board of Trade unit, was brought into operation on the 1st July last. The Leeds Corporation, in the last session of Parliament, introduced a Bill authorising them to construct and work electric or other tramways, which affected the company's interests, and the directors obtained the insertion of a clause in the Bill by which the rights of the company are protected. The company's mains have been extended to Chapeltown, which has resulted in an encouraging demand for current. It having become apparent that the plant in operation will not suffice to meet the requirements of current that may be expected to arise not later than the winter of 1896, the directors have decided upon an important extension of the company's works, and arrangements are being made to carry out that object. In order to obtain the necessary capital, the remainder of the authorised capital, consisting of 9,900 ordinary shares was offered to the existing ordinary shareholders, *pro rata*, to their previous holdings, of which 8,848 shares were taken up. The retiring directors, Mr. Grosvenor Talbot and Mr. Robert Hudson, being eligible, offer themselves for re-election. Mr. John Gordon, junr., offers himself for re-election as auditor.

Cambridge Electric Supply Company, Limited.

THE directors' report says that during the year 1895 there has been added to the company's mains, the equivalent of 3,016 8-candle-power lamps, making the total 14,660. A new bay has been added to the boiler shed with an additional boiler to meet the increased demand. Owing to the flood in November, 1894, the company had to deepen their main intercepting wells to provide a constant supply of water, this was successfully carried out during the summer months. A new 75 unit dynamo and engine has just been added to the plant, bringing up the total capacity of the station to 525 units; this machine began work on January 11th of the present year. A length of 903 yards of main conduit pipe has been added, making a total of 13,051 yards, whilst another sub-station fully equipped, has been constructed to supply Trinity College, Trinity Street, Bridge Street, and Sidney Street. At the end of the year, one-third of the total supply was delivered from the sub-stations, resulting in a marked economy in fuel. The number of units supplied during the year has been 150,510, against 112,084, an increase of 38,426 or 35 per cent. The company has made a profit on the year's working of £1,489 8s. 10d., which added to £19 18s. 2d. brought forward from last year, leaves £1,509 7s. 0d., and after paying £48 11s. 11d. interest on debenture capital, there remains a balance of £1,460 15s. 1d. Your directors therefore advise the payment of a dividend of 3½ per cent., absorbing £1,126 17s. 11d. leaving £333 17s. 2d. for depreciation and carrying forward. During January, 1896, lamps equivalent to 860 8 candle-power have been connected in the New Theatre. Mr. Wm. C. Hall and Mr. J. B. Simpson retire by rotation, both are eligible and offer themselves for re-election. The auditor, Mr. Arthur Rutter, also offers himself for re-election.

Anglo-American Telegraph Company, Limited.—The directors have resolved, after placing the sum of £12,000 to the credit of the renewal fund, to recommend to the proprietors at the next half-yearly general meeting of the company to be held on February 7th next, the declaration of the following dividends:—1. A balance dividend of 18s. per cent. upon the ordinary consolidated stock for the year ending December 31st, 1895. 2. A balance dividend of £1 16s. per cent. upon the preferred stock for the year ending December 31st, 1895, both payable on February 8th next, less income-tax, to the stockholders registered on the books of the company on the 21st inst. After paying the foregoing dividends there will be a balance of about £794 to be carried forward to the next account. The above dividends, together with those already paid, will amount to £2 9s. per cent. on the ordinary consolidated stock, and £4 18s. per cent. on the preferred stock for the year 1895. The register of transfers will be closed from January 24th to February 7th, both days inclusive.

Stock Exchange Notices.—The Stock Exchange Committee have appointed Wednesday, February 5th, a special settling day in City of London Electric Lighting Company, Limited—Provisional certificates of a further issue of £100,000 5 per cent. debenture stock, and have ordered same to be quoted in the Official List.

Application has been made to the Stock Exchange Committee (1) to appoint a special settling day in, and to grant a quotation to—Brush Electrical Engineering Company, Limited, £105,000 4½ per cent. second debenture stock.

Submarine Cables Trust.—On and after February 1st the sum of £1 5s., balance of the coupon due October 15th, 1895, will be paid by Messrs. Glyn, Mills & Co., of 67, Lombard Street, between the hours of 10 a.m. and 2 p.m. The coupons should be left with the bankers for examination four clear days before payment.

Eastern and South African Telegraph Company, Limited.—The payment by warrants on February 1st of interest for the half-year ending January 31st on the 4 per cent. mortgage debentures is notified. The transfer books will be closed from January 28th to February 1st, both days inclusive.

Venezuela Telephone and Electrical Appliances Company, Limited.—Coupon No. 11 of the 5 per cent. first mortgate debentures, due January 31st, will be paid from that date at the Consolidated Bank, Threadneedle Street, E.C., or at Messrs. Westendorp & Co.'s Bank, Amsterdam.

St. James's and Pall Mall Electric Light Company, Limited.—The share transfer books will be closed from January 27th to February 10th inclusive, preparatory to the payment of dividends for the half-year ended December 31st, 1895.

Eastern Telegraph Company, Limited.—The coupons on the 5 per cent. debentures due February 1st will be paid on and after that date at the banking house of Messrs. Glyn, Mills, Currie and Co., 67, Lombard Street, E.C.

Cuba Submarine Telegraph Company, Limited.—The directors recommend a dividend on the ordinary shares at the rate of 8 per cent. per annum, tax free, for the half-year ended December 31st.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending January 26th, 1896, were £994; week ending January 27th, 1895, £998; decrease, £4; total receipts for half-year, 1896, £4,085; corresponding period, 1895, £3,999; increase, £86.

The Liverpool Overhead Railway Company. The receipts for the week ending January 26th, 1896, amounted to £1,043; corresponding week last year, £943; increase, £100.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending January 24th, 1896, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company Limited, were £2,804.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1893.	1894.	1895.	Closing Quotation, Jan. 21st.	Closing Quotation Jan. 29th.	Business done during week ended Jan. 29th, 1896. Highest.	Lowest
173,400£	African Direct Teleg., Ltd., 4 % Deb.	100	4 %	4 %	...	100 —104	100 —104	...	...
1,912,880£	Anglo-American Teleg., Ltd.	Stock	£2 11s.	£2 2s.	£2 9s.	45 — 47	47 — 49	45	...
2,993,560£	Do. do. 6 % Pref.	Stock	£5 2s.	£4 4s.	£4 18s.	85½— 86½	87½— 88½	89	85⅞
2,993,560£	Do. do. Defd.	Stock	...	...	...	6½— 6⅝	7½— 8	7⅝	6½
130,000	Brazilian Submarine Teleg., Ltd.	10	6½% §	7 %	...	13 — 13½	13½— 13⅝	13 1/16	13¼
75,000£	Do. do. 5 %, Debs., 2nd series, 1906	100	5 %	5 %	...	110 —114	110 —114	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 44,000	5	... §	2½%	...	3¼— 3⅜	3¼— 3⅜	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	...	160 —170	160 —170	...	...
224,850	Consolidated Telgp. Const. and Main., Ltd.	10/-	2 % §	1½%	...	1/16— 1/8	1/16— 1/8	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	...	12½— 13½	12½— 13½	12½	...
6,000	Do. 10 % Pref.	10	10 %	10 %	...	20½— 21½	20½— 21½	...	...
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	...	3½— 4½	4 — 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	...	10 — 10½	10 — 10½	...	...
30,000£	Do. do. 4½ % Debs. Nos. 1 to 6,000 ...	50	...	4½%	...	102 —105 %	104 —107	..	..
60,710	Direct United States Cable, Ltd.	20	2⅝% §	2 %	...	8 — 8¼xd	8¼— 9	8½	8⅜
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½% §	6½%	...	16¼— 16¾xd	16⅜— 17¼	17¼	16⅜
70,000	Do. 6 % Cum. Pref.	10	6 % §	6 %	...	17¾— 18¼xd	18 — 18½	18	...
102,100£	Do. 5 % Debs., repay. August, 1899	100	5 %	5 %	...	107 —110	107 —110	..	...
1,297,837£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	...	126 —129	126 —129	128	126½
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7 %	...	17 — 17½	17½— 18	17⅝	17½
54,100£	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	5 %	5 %	...	100 —104	100 —104	102¼	101
194,300£	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5 %	...	101 —104	101 —104	...	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	4 %	...	128 —131	129 —132	129½	...
80,600£	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5 %	...	100 —104	100 —104	...	...
107,600£	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5 %	...	101 —104	101 —104	102	...
300,000£	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1909	100	4 %	4 %	...	107 —110	107 —110	...	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	...	112 —115 %	112 —115%	..	...
180,227	Globe Telegraph and Trust, Ltd.	10	4⅝% §	4½%	...	9½— 10xd	9⅞— 10¼	10¼	9⅝
180,042	Do. do. 6 % Pref.	10	6 % §	6 %	...	16½— 17xd	16½— 17	16⅝	16 1/16
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅜%	8⅜%	...	21¾— 22¼	22 — 22½	22¼	22
180,000£	Do. do. do. 5 % Debs.	100	5 %	5 %	...	104 —107	104 —107	104½	..
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	...	46 — 49	46 — 49	48¼	47
100,000£	London Platino-Brazilian Teleg., Ltd. 6 % Debs.	100	6 %	6 %	...	105 —109	106 —110	...	...
28,000	Montevideo Telephone 6% Pref., Nos. 1 to 28,000... ...	5	4 %	4 %	...	2 — 2½	2 — 2¼	...	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5 % §	5 %	...	6¼— 6⅜	6¼— 6⅜	6¼	6¼
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	...	16 — 18	16 — 18	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	...	15½— 16½	16 — 17	...	...
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 119,234	5	5 %	5 %	...	6⅜— 6⅝	6¼— 6⅜	6 1/16	...
1,100,000£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	...	104 —107	104 —107	106	105
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	...	4¼%	...	0/16— 1/16	0/16— 1/16	...	...
100,000£	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	4 %	4 %	...	108 —111	108 — 111	...	...
11,839	Reuter's Ltd.	8	0 %	*nil*	...	4½— 5½	4½— 5½	4⅞	
3,381	Submarine Cables Trust	Cert	...	...	...	126 —131	126 —131	130	129¼
58,000	United River Plate Teleph., Ltd.	5	...	3 %	...	2½— 3	2½— 3	...	...
146,733£	Do. do. 5 % Debs.	Stock	5 %	5 %	...	90 — 95	90 — 95 xd	...	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	*nil*	*nil*	...	5½— 6½	5½— 6½	...	...
238,300£	Do. do. do. 5 % Debs.	100	5 %	5 %	...	101 —104	101 —104	103½	...
30,000	West Coast of America Teleg., Ltd.	10	*nil*	*nil*	...	1 — 2	1 — 2	...	...
150,000£	Do. do. do. 6 % Debs., repay. 1902	100	8 %	8 %	...	94 — 99	94 — 99	...	...
64,248	Western and Brazilian Teleg., Ltd.	15	2½%	3 %	...	9 — 9½	9 — 9½	9½	9⅛
33,129	Do. do. do. 5 % Pref. Ord. ...	7½	5 %	5 %	...	6½— 6⅝	6½— 6⅝	6⅝	...
33,129	Do. do. do. Def. Ord.	7½	...	1 %	...	2⅜— 3⅛	3 — 3⅛	3 3/16	3⅛
165,200£	Do. do. do. 6 % Debs. "A," 1880 Red.	100	6 %	6 %	...	103 —107	104 —108	...	...
206,400£	Do. do. do. do "B," do.	100	6 %	6 %	...	103 —107	104 —108	...	
88,321	West India and Panama Teleg., Ltd.	10	⅞%	⅞%	...	⅞— 1⅛	⅞— 1⅛	1 1/16	1
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	...	10¾— 10⅞	10¾— 11¼	10⅞	...
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	...	8½— 9½	9 — 10	9	...
80,000£	Do. do. 5 % Debs. No. 1 to 1,800 ...	100	5 %	5 %	...	108 —111	108 —111	...	...
1,777,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	7 %	7 %	...	113 —118	113 —118	...	...
164,300£	Do. do. 6 % Ster. Bonds.	100	6 %	6 %	...	102 —105	102 —105	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electy. Supply	5	4½%	4½%	...	5½— 5⅝	5½— 5⅝	...	...
10,277	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 10,277 ...	5	5 %	5 %	...	6¾— 7¼	6¾— 7¼	...	...
60,000	Do. do. do. 4½ % Deb. Stock Red. ...	Stock	...	...	...	115 — 118	115 —118	...	...
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000	10	...	5 %	...	12⅝— 13½	13½— 14½	14	13⅞
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	...	15⅝— 16¼	15⅝— 16¼	15 1/16	...
300,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	...	133 —137	134 —138	...	...
22,475	County of London and Brush Prov. Elec. Ligtg., Ltd., Ord. 1—22,475	10	...	...	...	8 — 9	8 — 9	...	...
10,000	Do. do. do. 6% Pref., £8 pd., 40,001—50,000	10	...	...	...	10½— 11	10½— 11	...	...
50,000	†Liverpool Electric Supply, all paid	5	5 %	5½%	...	7⅞— 8⅛	7⅞— 8⅛	...	...
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000 ...	10	2½%	3 %	...	10½— 11½	11½ — 12½	12	11½
150,000£	Do. 4½% first mortgage debenture stock	...	4½%	4½%	...	114 —117	115 —118	...	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	...	1 %	...	8½— 9	8½— 9	...	...
19,980	St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-20,080	5	4½%	6½%	7½%	8½— 9	8¾— 9½	9½	..
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	9 — 9½	9 — 9½	..	...
67,900	*Westminster Electric Supply Corp., Ord., 101 to 60,000 ...	5	4 %	5 %	7 %	8⅜— 9¼	8¾— 9¼	9¼	9

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

Unless otherwise stated all shares are fully paid. ‡ Dividends paid in deferred share warrants, profits being used as capital.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1893.	1894.	1895.	Closing Quotation, Jan. 21st.	Closing Quotation, Jan. 29th.	Business done during week ended Jan. 29th, 1896. Highest.	Lowest.
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000	3	5 % §	2½%	...	1 — 1⅛	1 — 1⅛	1⅛	1
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	6 % §	3 %	...	1⅝ — 1⅞	1⅝ — 1⅞	1⅝	...
125,000*l*	Do. do. 4½ % Perp. Deb. Stock.... ...	Stock	4½%	4½%	...	112 —115	112 —115	113½	...
630,000*l*	City and South London Railway	Stock	1½%	1½%	1 1/16%	40 — 42	40 — 42	42	40½
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	3 % §	*nil*	...	2 — 2½	2 — 2½	...	...
89,261	Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 89,261	5	7 %	5 %	...	1½ — 1⅝	1½ — 1⅝	...	...
17,139	Do. do. do. "A" Shares 01—017,139	5	7 %	5 %	...	3 — 4	3 — 4	...	...
100,000	Do. do. do. 4½% Deb. Stock Red. ...	Stock	...	4½%	...	104 —107	104 —107 xd	...	...
110,000	Electric Construction, Ltd., 1 to 110,000	2	*nil*	*nil*	...	⅝ — ¾	⅝ — ¾	...	...
12,845	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	2	7 %	7 %	...	2 — 2½	2 — 2½	...	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil*	*nil*	...	½ — ⅝	⅝ — ⅞	⅞	...
69,385	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	*nil*	*nil*	...	⅝ — ¾	½ — ⅝	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300	5	*nil* §	*nil*	...	¼ — ½	¼ — ½	...	...
9,600*l*	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	*nil*	*nil*	...	9½ — 10½	9½ — 10½	...	...
10,000	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	5 %	6 %	...	13½ — 14½	13½ — 14½	13 13/16	13⅜
3,000	Do. do. do. 7% Pref.	10	7 %	7 %	...	15½ — 16½	15½ — 16½	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	...	...	...	108 —111	108 —111	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	12½%	10 %	...	20 — 21	20½ — 21½	22	20½
200,000*l*	Do. do. do. 4½ % Deb., 1896	100	4½%	4½%	...	102 —104	102 —104	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	1 %	1½%	2⅞%	11 15/16 — 12 3/16	12⅜ — 12½	12 5/16	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	15⅝ — 16	15⅝ — 16	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	20 %	20 %	...	43 — 45	44 — 46	45	44½
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	...	102 —105 xd	102 —105	...	...
54,000*l*	Waterloo and City Railway, Nos. 1 to 54,000, £4 paid ...	10	...	...	...	4⅜ — 5	4 7/8 — 5⅛	5	4⅜

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 60°/ for 189

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1893—0°/₀§; 1891—7°/₀§ 1890—8°/

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (fully paid), 5⅜—6¼.

Electric Construction Corporation, 6 % Debentures, 95—100xd.

House-to-House Company (£5 paid), 3⅜—4¼.

Do. do. 7 % Preference, of £5, 8—8½.

Do. do. 4½% Debentures of £100, 108—110.

Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid) 7⅜—8¼; 1st Preference Cumulative 6 %, £5 (fully paid), 6⅜—7¼.

Liverpool Electric Supply, £5 (fully paid), 7⅜—8¼

London Electric Supply Corporation, £5 Ordinary, ⅜—⅝.

Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 6⅜—7¼.

Bank rate of discount 2 per cent. (February 22nd, 1894).

THE THEORY OF LEAD ACCUMULATORS.

By C. LIEBENOW.

In his well-known manual of electro-chemistry, Leblanc has sought to prove a theory of accumulators on the basis of the theory of ions, relying upon the assumption that positive lead ions appear upon the positive electrode. For about two years I have entertained another view respecting the phenomena which are manifest in the lead accumulator, in which Leblanc's assumption is not necessary, and which permits a very simple description of these much debated phenomena.

I start with the supposition that when a substance in aqueous solution can dissociate in a manifold way, this actually happens; and it is known that there are certain ions for the liberation of which the possibility exists in all solutions of lead oxide.

Concerning the solution of lead oxide in potash and similar alkaline liquids, Michaelis (*vide Lehrbuch der Anorganische Chemie*, Vol. iii., p. 1,176), says "Lead oxide in its relation to the strong base actually plays the part of an acid, hence, in alkalies we get Pb (O K)$_2$, Pb (O Na)$_2$. Lime water and milk of lime also dissolve the oxides of lead. A compound of lime and lead oxide is obtained in needle-shaped crystals when milk of lime and lead oxide are boiled, and the solution evaporated out of contact with air."

J. Krutwig (*Deutsche Chem. Ges. Ber.*, 1882, p. 1,264), by the addition of nitrate of silver to an alkaline lead solution obtained a yellow precipitate, quickly turning black in the air, and which, after being washed with hot potash solution and then with hot water, possessed the composition Pb O$_2$ Ag$_2$ + 2 H$_2$ O or Pb (O Ag)$_2$ + 2 H$_2$ O.

We have here also the combinations

$$Pb\begin{matrix}O\,K\\O\,K\end{matrix};\quad Pb\begin{matrix}O\,Na\\O\,Na\end{matrix};\quad Pb\begin{matrix}O\\O\end{matrix}>Ca;\quad Pb\begin{matrix}O\,Ag.\\O\,Ag\end{matrix}$$

The splitting of these into ions in aqueous solution obviously proceeds in the same way as the anions $\bar{P}b\,\bar{O}_2$ and the kations $2 \times \overset{+}{K}$; $2 \times \overset{+}{Na}$, $\overset{++}{Ca}$ or $2 \times \overset{+}{Ag}$ are formed. The latter can, in any case, be replaced by other kations; for example, in place of the two $\overset{++}{Ca}$'s, or of the two single $\overset{+}{Ag}$'s, the two $\overset{++}{Pb}$ could be introduced. We then have the pair of irons $\bar{P}b\,\bar{O}_2$ and $\overset{++}{Pb}$.

The neutral molecule possesses the formula $Pb\begin{matrix}O\\O\end{matrix}>$ Pb, and can be split obviously into $\bar{P}b\,\bar{O}_2$, $\overset{++}{Pb}$, or into $\overset{++}{Pb}$, $\bar{O}_2\,\bar{P}b$, in which the different position of the lead will show that it is immaterial which of the two lead atoms of the molecule passes into the anion or kation.

By combining lead oxide, Pb O, with water, the following pairs of ions are possible: $\bar{P}b\,\bar{O}_2$, $\overset{++}{Pb}$; $2\,\bar{O}\,\bar{H}$, $\overset{++}{Pb}$ and $\bar{O}\,\bar{H}$, $\overset{+}{H}$. Since Pb O$_2$ ions actually exist, I, therefore, feel justified in the assumption that they also actually appear under these particular circumstances, even though less numerously.

If any acid be added to the above solution, the hydrogen ions of it will gain possession, to a large extent, of the $\bar{P}b\,\bar{O}_2$ ions, in order to form neutral water molecules and $\overset{++}{Pb}$ ions, according to the equation

$$\bar{P}b\,\bar{O}_2 + 4\,\overset{+}{H} = 2\,O\,H_2 + \overset{++}{Pb}.$$

But, by the continual breaking up and formation of neutral molecules and ions, $\bar{P}b\,\bar{O}_2$ ions, amongst others, will always appear, and although the "life" of an individual may be comparatively short, some such ions may be existing in the solution at any time.

The same ions will result from the solution of lead salt in water. Thus 4 O H_2 and 2 Pb S O_4 can change in the following way

$$(4\,O\,H_2, 2\,Pb\,S\,O_4) = (4\,O\,\bar{H}, 4\,\dot{H};\ 2\,\dot{\dot{P}}b,\quad 2\,\bar{S}\,\bar{O}_4)$$
$$= (Pb\,O_2, Pb + 2\,O\,H_2;\ 4\,\dot{H},\quad 2\,\bar{S}\,\bar{O}_4)$$
$$= (\bar{P}b\,\bar{O}_2, \dot{\dot{P}}b;\ 2\,O\,H_2;\ 4\,\dot{H},\quad 2\,\bar{S}\,\bar{O}_4)$$
&c., &c.

Now if n, m, o, p, and q are positive factors, then in a solution of lead sulphate there are the following anions :—

$n \times Pb\,O_2$, $m \times \bar{O}\,\bar{H}$ $(o + p) \times \bar{S}\,\bar{O}_4$, $q \times H\,\bar{S}\,O_4$; and the following kations :—$(n + o) \times \dot{\dot{P}}b$ and $(m + 2p + q) \times H$ are possible.

Amongst these factors may be one which is much greater than the others. It is then admissible for the calculation of the electrolytic conducting power of the solution to neglect all others and only to attach importance to this one.

In a certain sense, independent of these numbers and their relation, the result of the electrolysis of such a salt solution is normal if the current is chosen small enough with regard to the electrode surfaces, so that several kinds of ions may not simultaneously precipitate on the same electrode. In such a case that ion which requires the least expenditure of electrical energy for its separation separates itself first, irrespective of the number of the existing ions. At the cathode, at the same time, there appears the two kinds of ions, $\dot{H}$ and $\dot{\dot{P}}b$, from which they are withdrawn, the former in a gaseous the latter in a more or less solid condition. The separation of the lead demands a less expenditure of energy.

At the anode there is either $\bar{P}b\,\bar{O}_2$, $\bar{O}\,\bar{H}$, $\bar{S}\,\bar{O}_4$, or, possibly, $H\,\bar{S}\,\bar{O}_4$. From these the $\bar{P}b\,\bar{O}_2$ becomes separated as peroxide of lead.

The separation of either, or both, of the ions may be prevented by admitting other ions into the solution for which the work of separation is less than for the above. If, for example, copper chloride be added to the solution of lead salt the copper becomes precipitated on the negative pole in place of the lead, while, as before, on the positive electrode peroxide of lead precipitates. As we have now to do with it in a solution with ions and molecules continually decomposing and forming in the same way, after the separation, by means of the current of electricity, $\bar{P}b\,\bar{O}_2$ ions still appear and are in the solution as long as Pb is in the same. It will be recognised that, in this manner, all the lead in the solution is separated as peroxide (Luckow process).

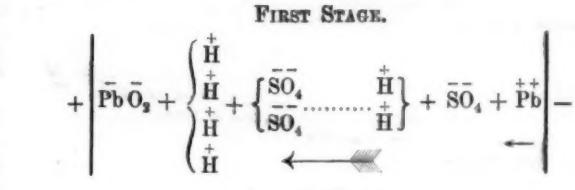
By adding oxalic acid to the solution instead of chloride of copper, $\bar{C}_2\,\bar{O}_4$ ions appear as new ions which precipitate more easily than the $\bar{P}b\,\bar{O}_2$ ions. Under these circumstances, the lead of the solution will be separated at the cathode as metallic lead, while carbonic acid is developed at the anode.

In the lead accumulator the processes are probably as follows : — The lead and probably the water contribute almost nothing to the conducting power of the electrolyte, for the lead *per se* is very little soluble and the water disinclined to dissociate. The conductivity on the other hand is largely affected by the sulphuric acid. As soon as a current of not too great intensity passes through the accumulator, the ions, $\bar{P}b\,\bar{O}_2$ and $\dot{\dot{P}}b$, are thrown down. On account of their smaller number, they would quickly become exhausted in the immediate proximity of the electrodes if from the sulphate of lead in the electrodes after the precipitation new molecules did not immediately pass into solution, through the dissociation of which substitution is made for the separated ions. When all the sulphate of lead from one of the two plates has passed away owing to the action of the solution, &c., and is reduced to lead peroxide, the next most easily separable ions separate themselves ; these are the hydrogen ions.

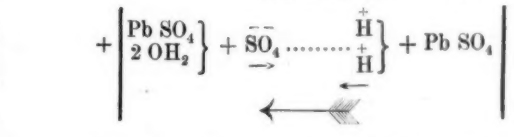
The above phenomena consisting of the continuous formation of $\bar{P}b\,\bar{O}_2$ and $\dot{\dot{P}}b$ ions from sulphate of lead and water molecules, and the separation of these ions from the electrodes by means of the current, passes in the reversed manner as soon as the current permits another current to arise, by means of which corresponding external work is again rendered.

The following scheme, explanatory in a somewhat diagrammatic sense, has been conceived by me :—

FIRST STAGE.



SECOND STAGE.



In this scheme the thick perpendicular lines represent the electrodes, the small arrows the direction of movement of the ions, the large feathered arrows the general direction of the positive current in the electrolyte.—From the *Zeitschrift für Elektrochemie*, xix., second year, 1895—6.

COALLESS CITIES.

PROF. CROCKER has been writing on coal-less cities in *Cassier's Magazine*, which kindly emphasises the paper by an illustration resembling part of Oldham, with the smoke inspector on his holiday. He would abolish the use of coal in cities altogether, and supports his reason by stating the coal consumption of New York to be 6,000,000 tons per annum, producing 22,000,000 tons of carbonic acid, as compared with about half a million tons of the gas produced by its 1,800,000 inhabitants ; a dreadful picture enough, but, so far as New York is concerned, or was when we last visited it, we think the odd half million tons are more harmful than the 22,000,000 which, when any breeze at all is blowing, probably blow well out of the city radius. Soot descends in other cities where, unlike New York, the coal is not smokeless, and we acknowledge all that Prof. Crocker says of dust, of the increased number of horses used in carting the ash and the coal, but in the matter of the carbonic acid, we doubt its harmful effects. Had the professor said sulphur, we could have better acknowledged his objections. Country air is, therefore, purer, more because of the lack of people, traffic, and street emanations, than because of the fuel question. Nevertheless, we in London or other English cities using bituminous coals, may welcome any proposition to do the coal burning, say, on the flats of Essex or on Chatmoss, so long as there is not a wind to blow the smoke our way, and Prof. Crocker essays to show how the end is to be gained. Energy cannot, he thinks, be brought in as steam. The success of a steam plant, even with a limited radius of supply, is doubtful. Hot water is also out of the running ; gas would but put us in an almost equally bad condition as coal, but on this score we cannot agree. It would be clean, but it would also be too doubtfully safe ; and it has numerous other disadvantages. Electricity alone holds the field. Its sole use is perfectly feasible, though not likely to become so for 50 or 100 years ; but it would be a financial success says our author. How should it be generated, distributed, and used ? Passing over the fortunate city with practicable water-power, the city is considered which desires to generate its electricity at a point 10 miles distant. Such a point—we may be forgiven, perhaps, for digressing, to say it would soon become a little city of itself, burning a great deal of coal in the bad old way—should have cheap delivery for coal, ample water for boiler and condensing purposes, and so on. The engine-power would be chiefly in the shape of 20,000 H.P. units, like those of a man-of-war, or big merchant steamer, and would be direct coupled to large dynamos. We seem to have heard of, or seen in embryo,

just such a station, and the proposed 10,000 voltage has a familiar ring. To start with, the total power should be 100,000 H.P., and would be several times this when large enough for a great city. It might be wise to step up to the above voltage, but four 2,500-volt generators in series would serve if direct currents were employed. At the city limits the current would step down to 2,500 at convenient points, whence the mains would be carried underground to sub-stations to transform to 250 volts. These latter stations would be very numerous, so as to keep down the length of low tension main, this being the principal item of cost. To simplify this local portion, he suggests a transformer sub-station in each block of the city, and would carry local circuits from the secondary round the block, either as air lines, or on brackets on back walls, or in troughs on the house tops. The sub-stations would be in cellars of some building, and an attendant could take charge of 10 such stations. As to cost of current, Dr. Emery's figure of ·2d. per horse-power-hour for continuous work is chosen, the basis being 1·25 lbs. of fuel at 9s. per ton, an economy that it is—probably vainly—expected, or hoped, might be attained. Possibly with the gas engine of the near future it might be reached. The figure is increased to ·3d. by reason of inequality of the power consumed at different hours and seasons. Conversion and incidentals bring it to ·5d., conductors of a capacity of 7,500 amperes and of 7·5 square inches area at 7d. per pound with insulation armour, interest, and maintenance, raise the cost to ·525d.; transformer stations and labour, and other incidentals, to ·575d.; but the 2,500-volt feeders should not have an average length of over two miles, and with that limit their combined area would be 30 square inches for an amperage of 30,000, and the cost is now ·6d. Sub-transformer stations, with carriers aggregating 300 square inches, and not averaging more than 500 feet in length, are responsible for raising cost to ·66d. To save confusion, all loss is bulked together as 15·5 per cent., and the cost becomes ·72d., and thus a penny rate is supposed to give a margin for profit and miscellaneous expenses, a rate so far from visionary that the 24 hours' supply from Niagara is given for but 0·1d. per H.P. hour. Still, the figures are very optimistic, and even when he refers to heating by electricity, our author takes a roseate view. True there is no waste in electric heating, but how small is the proportion of energy in the current as compared with the energy in the coal supplying it, and which is so much more fully realised in a stove. The steady load due to continuous heating would, however, be favourable to cheapness. Such schemes are, perhaps, useful as pointing to possibilities, but would it not be, perhaps, more serviceable to walk before running, and to suggest more modest attempts. A few large stations in each city with a system of hot water heating would be more feasible. The removal of power stations out of city limits is apt to be too much insisted upon. With reasonable care the smoke fiend may be exorcised. It is not the tall chimney that makes the pungency of the fog, but the thousands of house fires discharging their fumes within 50 feet of the ground. The ordinary fog is often a mere superficial and thin layer, which does not always reach down to the ground, but simply hangs above the level of the house chimneys, and shuts in the smoke of these, while the tall factory chimney projects through the fog into the sunlight above, and its smoke is blown away. We want the few tall chimneys under skilled supervision of combustion, and we want to abolish the many small ones.

Electrical heating can to-day be used by the rich. If everyone is to be obliged to use it, we fear that many there be who will go cold, while, if only the rich are to use it, then *cui bono;* we shall have the poor man's smoke left.

It is a little unfortunate that the professors who figure so largely in schemes of this sort usually base their ideas of the outer world on the style of building in which their own labours are conducted, and so find it difficult to realise the different conditions which prevail about the Five points or the Seven dials. There can be no such great schemes until the mass of the people is fit for them, and at present rates of progress it will not be in another 100 years. Why, even to-day, the people who pose as the best instructed in the world, would go to war at the bidding of their autocrat emperor and not dare to make a protest.

ELECTRICALLY OPERATED FACTORIES.

In advocating the use of electric motors for machinery driving, it is perhaps just as well that the advocate should have a bias in favour of the system, and in Mr. Crompton's article on the electrical operation of factories in the January number of *Cassier's Magazine*, some trace of this bias may be observed in his remarks on toothed gearing, which he condemns in a way that seems to indicate that Mr. Crompton has been unfortunate in his experience. The advocates of electrical transmission are apt to protest too much. They get hold of the idea of the electrical motor, and carry it to an absurd extent, and would put a motor to every little machine in a big factory to the entire exclusion of shafting, though in many cases a motor to each room, or, as Mr. Crompton suggests, to a group of machines, may be as far as it is wise to sub-divide. Electrical operation finds its best field in large and scattered works, not so large but what the power may be generated under one roof, and yet easily within range of economical wiring. Mr. Crompton suggests the isolation of the buildings of an explosives factory as affording an illustration of a works favourable to the electrical principle of transmission.

Large and heavy tools are also under conditions which are apt to show an economy for electrical driving, for the reason that large tools, such as a plate-shearing machine in a bridge works or boiler shop, or a heavy beetling frame in a bleach works, are often placed so far away from the source of power that the ratio of shafting to total energy used is small. But where 50 or 100 machines are run at one speed in one room, the use of so many separate motors would not, we think, be found to be an economy. It was no unusual thing before the days of fireproof factory building to find the machinery in two rooms all driven off a single shaft placed in the lower room. In such a case the shafting ratio per machine was low, and these conditions prevail in textile factories. There is also to be considered, in relation to the use of separate motors, that a uniform speed of machinery is very important to ensure uniformity of product as well as to keep the peace between the operatives, who would be exceedingly disagreeable if there were any reason to suspect a difference of front roller speed as between one frame and another. Such cases are, therefore, best met by the group system, and we are glad to find that this is recognised. These considerations do not apply in engineering works, and our author thinks that before long there will be separate motors to every small tool, because motors are becoming so cheap. Obviously, this end will be easier attained in such establishments as have already got an electrical system in operation, for there would be more likelihood of such works purchasing their new tools ready fitted with motors, and the cost of a motor so fixed would partially be paid for by the saving in countershaft and belting. There would not, however, be much saved in fuel; but this economy is real and undeniable in the large and scattered works, whether power be transmitted by shafting or by steam piping.

It is claimed that 500 horse-power at the tools will, in ordinary cases, require a steam engine power of 1,175 horse-power. With coal at 12s., and a year of 2,950 hours, the cost of a horse-power is worked out at £12, including £1,480 for wages, £600 for stores, and £1,600 for repairs and depreciation; coal being £2,260. These are Mr. Crompton's figures, not ours. Substituting electricity, he would still use three engines, and group them in one room. They would need to indicate 680 H.P. only, and coal would cost only £1,080, wages £375, stores £260, repairs and depreciation £1,300, or a total of £6 per H.P. year, figures which he states can be well established.

In discussing the question of large articles to be machined, Mr. Crompton touches firmer ground in advocating the moving of the machine to the work, rather than the work to the machine. This is a procedure to which the motor lends ready aid. In large engine shops the boring of the cylinders can as well be done by a portable boring bar as in the most solidly devised boring mill, and there are often numerous small pieces of work to be done upon large castings that might just as well be performed simultaneously with possibly the main operation upon the piece, and in this way time can be saved that is of great value, and that is now wasted when only only one operation is possible at one time.

Though alternating current motors have advantages in the shape of the safety with which they may be placed out of the way, and requiring no attention at commutators, still the direct current is more useful, in that it can be used for light, for welding, annealing, local hardening and other purposes. In delivering his judgment on the class of generating machinery to be employed, Mr. Crompton, needless almost to say, plumps for direct coupled Willans engines and two or four pole dynamos, and he states there are many plants now running which start on New Year's Day, and run without any stop whatever until Christmas, Christmas week being filled up by cleaning up, and New Year's Day sees a fresh start for another 8,592 hours. It would have been well to have given the names of a few of these, especially as the article concludes with a recommendation to factory owners to purchase such a plant.

IMPROVEMENTS IN SUBMARINE CABLES.

AMONG recently published specifications of patents is to be found one for improvements in electric cables, which claims the employment of aluminium and its alloys in lieu of iron or steel, as usually employed in the sheathing of submarine telegraph cables.

Apart from the real subject matter of the patent, there are some incidental remarks which are certainly interesting. The provisional specification runs as follows:—"In submarine cables made in accordance with this invention, aluminium, and alloys of aluminium are substituted for iron or steel in the sheathing, with the object of preventing corrosion and decreasing weight. In this way the depth from which a cable may be successfully lifted and repaired is increased, also the amount of jute at present necessarily used in the manufacture for lightening the cable, and protecting the outside from corrosion is diminished."

This is the first time we have ever heard that the addition of jute to a cable lightens it. Jute, when in water, and therefore saturated, is heavier than water, and as used outside cables, is usually loaded with various so-called preservative compounds. In no way can the addition of jute to a cable lighten it. Every sailor knows that ropes, whether made of jute, hemp, or manilla, will not float but for a very short time. What it does do is to increase the bulk, and therefore decrease the speed of sinking of a cable; a result which, by itself, is certainly of no advantage to the owner of the cable, though it may be to the contractor for its manufacture and laying.

In the complete specification occurs the following sentence: "The corrosion of the iron or steel sheathings of submarine cables, which has been found to take place even when they are laid on good mud and clay bottoms, has the effect of allowing the gutta-percha core to be exposed in places to the deteriorating effects of decaying animal and vegetable growths."

This is a thing we have never heard of before, and on which we should be glad to be enlightened. Now for the main claim of the patent. It struck us at first that possibly the patentees might have discovered some new alloy which possessed remarkable qualties, but we find that, preferably, aluminium is used as it is commonly met with in commerce, or alloyed with small percentages of copper and other metals. On the authority of Mr. A. F. Yarrow—who, perhaps, knows as much about aluminium as anyone else—this metal when alloyed with 6 per cent. of copper is about one-third of the weight of steel, and possesses a tensile strength of between 14 and 16 tons per square inch. Weight for weight such aluminium would, therefore, be about equivalent to steel of a tensile strength of 45 tons to the square inch. In water, however, it is barely one quarter as heavy as steel, so that for submarine cables this 45 tons must be increased to 60. Wire of this quality is very generally used for deep-sea cables, but certainly not for very deep water, in which case 90 tons to the square inch would be nearer the mark.

As to the non-corrodibility of the metal, Mr. Yarrow states that plates of it corroded to the extent of 4 per cent. per annum when in sea-water. The Norfolk Navy Yard reported the aluminium used in the Texas torpedo boats to be an utter failure. It corroded even when exposed to salt air. When in the neighbourhood of copper serious galvanic action takes place; for instance, an aluminium boat which happened to be moored near a copper-sheathed vessel suffered severely. Some alloys, however, are said to corrode much less than others.

Now as to price. The *Aluminium World* for this month gives 50 cents as the cost per pound when in ton lots. Allowing for the difference in weights between aluminium and steel in an ordinary deep-sea cable, instead of the material for the sheathing costing about £8 a mile, it would come to £37, which is certainly a prohibitive price, and scarcely likely to be reduced sufficiently for many years to come. The *Moniteur Scientifique* said last year that half the aluminium now produced is used up in the iron industry. Perhaps submarine cables actually have a small percentage in them already.

We recommend a reference to some remarks we published on April 26th last year as to the use of nickel-steel wire for submarine cables, which we are informed have been taken note of by at least one manufacturer.

If it were not for the well-known name which heads the patent for the use of aluminium, we should not have thought the matter worth mentioning, but, as it is, unless we are much mistaken, the patentees are very much at sea in more senses than one.

PROCEEDINGS OF SOCIETIES.

Institution of Electrical Engineers.

AT the ordinary general meeting held at the Institution of Civil Engineers, 25, Great George Street, Westminster, on Thursday evening, January 23rd, Sir David Salomons, vice-president, occupied the chair. The formal business having been transacted,

The CHAIRMAN said it was only a week ago that they met in that room in a joyful spirit to move a resolution tendering their services to Her Majesty to assist her in case of need, in defending her throne and their country. In one short week those feelings of pleasure had been converted into feelings of sorrow. A cloud had come over the palace; a very estimable and venerable sovereign, a good mother and a good woman, had lost her son-in-law, and a beloved princess had lost, in this world, her husband. They knew well that when there had been a sorrow in this country or in any other country, afflicting any number of people, or even a single person, Her Majesty had always been the first to sympathise with them in their grief. At such moments as these they, as Englishmen, and as men, quite apart from nationality, joined in their hearts to express to the royal family, to the Queen and Princess now so distressed, their deep sympathy and grief with them in their trouble. He would ask them to pass a special resolution expressive of the great regret with which the Institution had received the news of the untimely death of His Royal Highness Prince Henry of Battenberg, and the desire of the members to be allowed to lay before Her Most Gracious Majesty their expression of profound sympathy with the Queen and Princess Beatrice in the great bereavement which had overtaken them. It was not necessary that this resolution should be seconded, but he understood that a member of the Council who had served in the Army for many years wished to say a few words, so that this resolution might go forth not only from the chair, but also from the Council and the members, as showing that it was not only one of form, but of sentiment on their part.

Major-General WEBBER said, in conformity with the wish of the Council, he had pleasure in being allowed to add a few words to those in which the Chairman had expressed the feeling which he had little doubt was felt by all those present, in common with all those members, associates and friends who were absent. Sir David Salomons had suggested the propriety of his saying a few words, but he should not do more than ask them to remember that it was in furtherance of a great wish to identify himself with the volunteer service in this country to which he had already belonged, and which was formed especially for purposes of defence, that led Prince Henry of Battenberg to volunteer for the Ashanti expedition, so that he might see some active, practical service, in the field. That nothing ensued to give him that active experience, although a great deal of practical work was done without a shot being fired, and although it resulted in the loss of his life, was a matter for rejoicing, so far as this country was concerned; but it was a joy tempered with grief in consequence of the loss of a man whom, if they did not know him personally, many of them had learned to regard with great friendliness.

The CHAIRMAN announced that the discussion on the papers by Mr. S. Mavor and Mr. Bathurst on wiring for electric light installations, would now be taken.

Mr. GEIPEL* said now that the existing rules of the Institution for wiring were on the point of revision, the two papers under discussion had an additional importance apart from the mere relation they had to the two particular methods advocated by their respective authors. He endorsed cordially the point urged by Mr. Bathurst as to the principal obstacle to the general adoption of electric lighting. It was undoubtedly the expense of wiring the building. Those of them interested in the supply of electricity were doing their utmost to reduce the cost of supply, the lamp manufacturers, as to the expense

* The speakers marked with an asterisk have corrected their remarks.

of lamps, were doing likewise, and yet, to judge from the tone of the remarks made at the recent Board of Trade Conference, an attempt was being made by some of them to increase this cost of wiring, through raising the standard of insulation to an unnecessarily high pitch. If, as he believed was the case, they were all desirous that electricity should benefit mankind to the greatest possible extent, then they must not saddle this work of wiring with more unnecessary conditions than they could possibly help. By all means let them protest against shoddy work, but do not let them put on needless refinement. Some of the rules of supply undertakings stipulated for as much as 75 megohms per lamp, quite an unnecessary standard. They knew that such rules were quite unterable, unless confirmed by the Board of Trade, and it was satisfactory to think that the persons really interested—namely, the insurance companies—were, so far, much less drastic. The Phœnix stipulation was 12·5 megs. per lamp, and 25 other leading companies stipulated that the leakage was not to exceed $\frac{1}{2000}$th of the total current, which at 100 volts equalled 2 megs. only per ampere. The present rules of the Institution were $\frac{1}{5000}$th of the total current, equal to ½ meg. per ampere, or $\frac{1}{1000}$th part of that he first mentioned. This appeared to be quite adequate. He regretted to see also a tendency amongst the engineers of low tension systems to force a 200-volt supply upon the consumer. Wiring contractors would do well to join the consumers and to protest emphatically against this practice; at any rate, until such time as absolutely reliable and cheap 8 C.P. lamps were obtainable for this pressure. Meantime it was sufficiently difficult to get 100-volt 8 C.P. lamps which would stand burning at an economical efficiency. It must be remembered that for economical reasons the renewals of 8-C.P. lamps should be less frequent than larger C.P. lamps, as there was a definite ratio between cost of current and renewals. The life of an 8-C.P. lamp should be about $\sqrt{2}$ times that of a 16-C.P., assuming that each lamp cost the same. The first question occurring to all of them was, did the methods advocated by the authors tend towards economy in first cost? He was afraid that that question was not answered by any reliable data; in fact, there was a noticeable absence in both papers of any figures as to cost. Perhaps the authors would give some data in their replies. In urging the advantages of his system, Mr. Bathurst said that he saved on the insulation, which was half the cost of the wire. But did he maintain that his tubes were supplied and fixed for the same price as the much abused casing or compo tubing? He thought this could not be so, more especially as Mr. Bathurst spoke of the necessity of trained workmen. In his (Mr. Geipel's) opinion, the extensive use of casing was largely due to the fact that there were always plenty of joiners to be had who did the work without special training. In speaking of the advantage of high insulation of his wires, he was afraid Mr. Bathurst forgot that the really weak points were in the switches, cut-outs and fittings. What Mr. Bathurst meant (on slip 4), by the actual strain C 2 B, he could not understand. C 2 B was simply a watt, and watts, as they all knew, were very different from a strain. With regard to the previous sentence in his paper, should it not read "with two faults in the pipe," &c., and not as he had it, "two conductors"? Perhaps he would make these two points clearer to them in his reply. He could not follow Mr. Bathurst in his statement that rust in pipes was unfavourable to insulation. Rust was a better non conductor than unoxidised iron. He had listened with great interest to Mr. Mavor's description of his well thought out system of concentric wiring, but he hoped that the members of that Institution and the fire insurance companies would not be alarmed at Mr. Mavor's somewhat pessimistic remarks and warnings as to the necessity for greater stringency. He could not at all agree with Mr. Mavor as to the unsightliness of wiring in the present system; there were numbers of houses in London where not a casing was visible, and he was not sure that if his concentric cable "blundered across ceilings and cornices," that it would look one bit better than casing put up in such a negligent manner. It was useless to attack the existing method on the score of unsightliness; cost alone was its vulnerable point, and unless the cost of the concentric wiring was about 50 per cent. less than it was about a year and a-half ago, he was afraid that system was not ready yet to help them. He spoke from experience, for about that time he got a quotation from a firm who made a speciality of that system for wiring a large mansion for about 1,000 lights. By these remarks he did not wish to discourage in the slightest either of the systems; by all means let them encourage the fire offices to give every chance of proving their worth. It was possible that by abolishing the insulation of the outer conductor the concentric system might become cheaper than casing. Indeed, he was of opinion that the Board of Trade might go a step further, and dispense with the insulation of the "outer" of all concentric low tension distributing mains. It might be necessary to slightly insulate the outers of the feeders to obviate telephonic interference and electrolysis, but the difference of potential between any parts of the distributing network was so small, that there appeared little necessity of insulation, especially as the "outer" was, even when insulated, invariably at earth potential. With such a system a considerable saving in first cost could be made, while Mr. Mavor's concentric system with uninsulated outer would work well in with it. As to the soldering of all contacts, that necessitated the use of a soldering iron whenever a fitting or switch required disconnection or connection to the circuit. Was not this an objection, as compared with the readily made mechanical contact? He agreed entirely with Mr. Mavor's remarks as to the importance of what he described as grouping the branch fuses at distributing centres, and he considered that the method should be made compulsory with all systems of wiring, especially as it involved no increase in first cost. He also agreed with Mr. Mavor's strictures upon the bayonet joint lampholder so much in vogue, and he would ask if any of the members could second his experience, which went to show that the Edison screw socket was a better holder? It certainly appeared to overcome Mr. Mavor's objections. Mr. Mavor admitted that a fault might be caused in his wires by a nail, for example, yet he proceeded to argue that he might sink his wires in the plaster, as it was never necessary to remove them. He could not agree with that. The compo tube provided a means of repairing the wires in such cases, without destroying any decorations. If he might be a little hypercritical, he would suggest to the authors the unsuitability of the word "lead;" would not "conductor" be a much more appropriate term? He was aware that in the fire risk rules of the Institution those terms were mixed up together, even in the same clauses. He did not, however, see the object, unless it was to give each term a turn, and show that there was no ill feeling. He hoped, however, that "lead" would be dropped in future rules.

Mr. HANDCOCK* said it afforded him great pleasure to see the prominence given lately to iron piping, and also that there was a general idea about that the time had come when they should make a move from their old friend, casing. He ventured to think on examining the iron pipe system before them, that although it was a step in the right direction, it might possibly be carried a little further. His firm were not altogether sure that insulating the pipe and reducing the insulation of the cable was exactly the right thing. In the first place, by putting the insulation inside the pipe they reduced its capacity a great deal. In the second place, they were not at all terrified with the thought that, as some people said, the life of vulcanised rubber was but three years. If that were the case, he would like to ask Mr. Bailey, for instance, whether in the case of the hundreds of thousands of pounds worth of vulcanised cables under his control he calculated that the depreciation was 33⅓ per cent.; and he would like to ask Messrs. Henley and the Silvertown Company the same thing. Without laying any particular claim to being the first to use iron piping, he ventured to think his firm had been to a certain degree concerned in promoting its introduction. They were aware that for some years past there had been a feeling that there was room in the electrical world for more of an engineering spirit, so to speak. Casing was not entirely satisfactory; it did not apply to all the requirements they were justified in asking of it. They knew that there had been on the market for some time past various iron pipe systems, but somehow or other no one had cared to take the plunge. But they were gratified to know that since they determined to introduce it into the Commercial Union Buildings and the Guardian Buildings and other places, it had increased in favour. The point was that in iron piping they found a system which gave them practically everything they asked for. First of all it was a system which could be put in whilst the building was going up; if the builder liked, he could mix his mortar on top of the electric light installation. Also the ubiquitous carpenter could not drive his nails through the electric light pipes, which was a considerable advantage. They found that they had with iron pipes a system which enabled them to put in all the pipes while the building was going up, and which enabled them to draw in the cables the last thing, and so start with an installation which was perfectly new, and not one which was three parts worn out before it came into use. They also found that if anything should happen to the wire, the contractor could draw the cables out again. He was afraid the question of disturbing decorations was not sufficiently considered, should it at any time be necessary to inspect the wire underneath. At the same time, it was necessary in putting the work in to take more precautions than with casing. All the joints must be vulcanised. It was not sufficient merely to have good materials, they must have good men, too, a fact which was too often overlooked. With second-rate materials and good workmen they could make a passable installation, but with first-class materials and second-class workmen they never would. Coming to the question of insurance, there was no doubt that for the past few years there had been a certain amount of feeling, and was this not because there had been a mistake more or less made in regard to the functions of the insurance companies? Insurance inspectors had had a difficult task to carry out, and he was very much afraid that the public had been under the impression that because an installation had been passed by an insurance inspector it was safe, and nothing could happen. Let them consider what it meant. Insurance companies, like other people, had to be guided by business considerations; if any of them were to follow the ideal, and say: "We will take nothing but the perfect installation," people would place the risk across the street, where it would most willingly be taken. It was a question of competition. Those gentlemen who represented the insurance companies had to ask themselves simply this question: "If this installation is passed as it is, will there be a greater risk than is incurred at the present moment with the illuminant it is to supersede? If there is a greater risk incurred by passing this electric lighting installation as it is, then we must put up the premium." On the other hand, supposing there had been a certain premium fixed when the building was lighted otherwise than by electricity, it was evident that if the dangers due to electric lighting were not greater than those due to gas, that company would not be justified in putting up the premium. It was evident they did not contend that they had reduced the risk; if they did so, he thought it was possible that in some cases the premium would be reduced; but as far as he was aware, that had never been done. It was a pity it could not be made known, or at all events driven home to the public in some way, that the insurance companies did not undertake the functions of a consulting engineer. They considered that if the premium now paid covered the risk, well and good; if not, the holder of the policy would say: "What point do you object to? What prevents you from taking the risk?" They would naturally say: "We want extra switches or fuses," whatever the case might be; but he did not think they claimed for a moment when they had passed an installation it was perfectly safe. To go a step further, they had to be guided a great deal in laying out an electric lighting installation by the requirements of insurance companies. Supposing the Institution of Electrical Engineers told them how they were to wire a building, and what was required, should that be binding on the insurance com-

panies? He thought not. The rules of the Electrical Engineers should form a code, to which anybody could appeal who wanted to know what, in the opinion of the experts of the day, was the best thing that could possibly be done, but for the insurance companies to say that we must alter our system of wiring, because it did not come up to the ideal, was entirely different. As time went on that would be realised. Considering the difficulties insurance inspectors had to encounter, he could not help thinking they did their work very well, with consideration for everybody concerned. There were one or two points he would like to mention in connection with the declaration they were usually asked to fill up. In the first place, in some of the companies' forms they had to answer this question, "What excess of current will the conductors safely carry?" He ventured to say no two members of the Institution would have the same opinion on that subject. They generally evaded the question by saying the current density was so much to the square inch, and left the insurance company to form their own opinion whether that was enough or not. He would suggest upon this point that the Institution should draw up clear and concise rules; the present method was unscientific and wasteful. In the smaller sized cables they might run up to 2,000 to the inch, but often it was not safe to exceed 500 to the inch in the larger sizes. What they wanted was a definite table which could be referred to at once, and they might say the electrical engineers have gone into the matter, and say for such and such sized cable you may put a certain amount of current through and no more. Naturally, as they got up to the higher side of the scale, they would be guided by the consideration of temperature, and as they got lower down the scale, all they would have to consider was the fall in voltage for a given length. Another question often asked was, "Is the length of cut-out proportional to the E.M.F.?" That, too, was rather a difficult question to answer. In the first place, no standard was laid down for them, and they had to choose an arbitrary standard of their own. Taking the Metropolitan Company as an example, they brought into the house 2,000 volts and transformed down to, say, 100; it was evident if they considered a cut-out on the secondary should be 3 inches long, then the cut-out on the Metropolitan primary circuit should be 5 feet long. There was something wrong there. On the other hand, if the Metropolitan cut-out represented a length of 3 inches, the cut-out on the secondary should be $\frac{3}{20}$ths of an inch! Passing on to what was a burning question of the moment, were they to have 50 volts, 100 volts, or 200 volts in their houses? It was a question capable of being looked at from many points of view. If they looked at it from the point of view of the central station engineer, they would say at once have 200 volts. If they looked at it from the point of view of the ordinary contractor who had to take what fittings he could get on the market at the moment, and did not want to spend too much on cables, they would say 100 volts. If they looked at it from the point of view of the consumer, he thought they would say, probably, considering the life of the lamps and the question of convenience, 50 volts. Many people said the last-named was old-fashioned. He ventured to think it was in some points of view, but it had many advantages. If they specified half a certain cross-section of copper in their cables, it did not make a very great difference in the contractor's prices in the case of wiring for medium sized installations; they did not get a corresponding reduction in their tenders. With 50 volts under ordinary conditions it was amazing what the life of lamps was at the moment. There were many places where they had had the same 50-volt lamps in use three or four years. He did not say they were in use every day. With 100 volts their experience was mixed. Apparently makers had had batches of unfortunate lamps; on all sides they seemed far more liable to that sort of thing now than in the past. When they got up to 100 volts, what might be called the limit of convenience was reached. That was to say, although the consumer might save a little in first cost of installation at times by going higher, he did not think the advantages counterbalanced the consideration of the life of the lamp. At the present moment lamps were run in London under very trying conditions on account of fluctuations in voltage. He thought that, as yet, it was rather premature to advocate 200 volts. They were told that when they had experience in the matter they would think rather more of it; they were told the life of the lamps was something remarkable; they were told they were portable, and did not break in transit, and several other things. But he still maintained that 200 volts was in the experimental stage. It had to come, but the makers of fittings were not ready for it. Those who were using it at the present moment were doing a most useful service, as it was only by actual use that the weak points could be developed and remedied. There was another point. When they put up the voltage to 200, it was an admirable thing from the central station engineer's point of view; they increased the capacity of their mains and reduced the efficiency of the consumer's lamps, obliging him to take more current to get the same amount of light. With regard to the three-wire system, they were told it was impossible, or next to impossible, to get a shock across the two outer wires. But although station mains were in such wonderfully good condition, curiously enough, the outer mains sometimes did go to earth, and also on many circuits people had not the confidence in the continuity of the supply that they should have. The result was that they would have a gas fitting somewhere in the neighbourhood, and it would happen sometimes the fittings themselves got in contact with the circuit. The result was that somebody took hold of the gas fitting and got a shock direct across the outer conductors, which meant in the case of the three-wire system 400 volts; in fact, they should bear in mind that a 200-volt installation might mean a 400-volt shock.

Mr. J. HARDIE M'LEAN * said he should like to speak from the point of view of the central station engineer. They had heard a great deal about details in connection with wiring, but his opinion was that even with the old-fashioned wooden casing they could have a great deal better wiring if more attention were paid to the work. The wiring affected them to a terrible extent; he did not think they half realised the extent to which it affected them. They (central station engineers) had to make their bread and butter by turning out current to the consumers; it was not their place to look after the other side of the business, but they were expected to do it. They were expected to inspect and pass the wiring of the premises to which they were supplying current, and it sometimes happened in Oxford that six or seven or a dozen installations were going on at the same time; if there were, say, half a mile between each, it would amount to something like a six miles' walk, and then 100 steps to climb, as was the case in some of the colleges, still, if they were expected to look at every bit of wiring that went in, it was clear they would not have much time to look after the company's work. This was a serious point. If they neglected the work and a fire occurred, the credit of the concern was at once called into question. Looking at it from the personal point of view, he wanted to know to what extent his own credit would suffer in case of a fire. He would like to see the fire insurance companies paying a little more attention to their own business, and leaving the station engineers to pay more attention to theirs. It very often happened that the work was finished before they received the application form, and customers would not allow them to lift up their floors and pull about their walls and ceilings to look at the wiring, and they had to content themselves with a casual inspection and the ordinary test. They had been shown all sorts of tubes and all sorts of joints and connections, but he could show them just as good things with the old wooden casing in connection with surface work. How many of those joints and connections would be behind the walls or under the floors? He had pulled up hundreds of yards of stuff improperly laid; he had been kicked about because he would not pass the work; he had had the principals of the contractors come down to his office and nearly kick him out of his own office. The previous speaker who had spoken of 200 volts said some things that were true and some, he thought, which were not quite true. He should like to see 200-volt lamps, but he was inclined to think that, in some cases, if 200 volts were turned on in some of the present installations the light would not be at the lamps, it would be somewhere else. He was glad to hear at the Board of Trade Conference that a little more power was to be put into their hands; at present they had only to be "reasonably satisfied" that all was right. He was glad to see one clause inserted, that if the insulation fell below a certain point they were bound to cut the installation off. He would cut them off! With regard to the insurance of buildings, at the present time the insurance companies were threatening to raise the premiums on central stations. He wished they would direct their attention to the consumers' premises and leave the stations alone. They had spent a large amount of money on iron and steel fireproof buildings, with flagged floors and steel and iron supports, and perhaps had not as much wood in the stations as would equal his own weight, and yet the insurance people were going to increase the premiums from 3s. 6d. to four times that amount. They were insured at Oxford for over £20,000, and it would be a serious thing for them if the insurance were raised three or four times. He had calculated that it would give him two more men in the engine room, one to look after the fire arrangements if necessary and the other to assist at running the plant.

Major-General WEBBER * said this question of insurance was one which was coming very close home to them, especially in connection with the fact to which the last speaker had referred, that the fire insurance companies were so irrational as to propose to raise the premiums on buildings which were constructed, they might say, practically incombustible, while they were overlooking the great fact that electric lighting, when properly carried out, was rendering the fire risk in dwellings much less than it was before. There was a very large field for the electric light which, on account of the practical prohibition of the insurance companies, had not yet been occupied. In all their seaport towns there were great warehouses where the fire insurance went up to from 7s. 6d. to 15s, and in consequence of the owners of those warehouses being told that if they displaced the present means of lighting, and put in the electric light, they would get no reduction, they did not care to go to the expense of changing. If the insurance companies employed as inspectors men who were thoroughly masters of the subject, no doubt they ought to advise their companies to reduce the premium rates on that class of buildings, and many of the owners would, in that case, adopt the electric light; but at present they had no inducement to do so. The question of insurance was such a burning one, and was becoming of so much interest, not only to the contractors, but also to the supply companies, that he thought if the insurance companies did not take some steps to reform their ways, and to reconsider and study the subject as they ought to do, competitors would grow up who would take the trouble to understand the diminished risks due to electric light, and insurance companies would be brought into existence who would insure at a premium considered from that point of view, such new insurance companies, as the spread of electric lighting installations proceeded, would get a very large business indeed. This was a matter which the financial and insurance world might well turn their attention to. In connection with all these systems of wiring, he might say that it was even possible to wire their houses in a more simple way than either by casing or tubes, and although it might be called old-fashioned, he would mention the case of his own house, where electric light had now been in full use for 10 years. The wiring was carried out by the conductors being fixed, some inches apart, to the face of the wall with saddles, and wherever the lead of the conductor of the opposite pole crossed beneath or above it to reach a lighting point, it was simply separated from the conductor of the other pole by a little sheet of ebonite made in the shape of a saddle, which provided an insulating separation of about $\frac{1}{16}$ths of an inch. These conductors had been painted and papered over several times, of course, not subjected to violence, and there had never been a short on any part of the house system. He did not mean to suggest that they should now wire houses in that way, but pointed it out as a good practical

example of wiring, which was at the time exceedingly economical, and was more so now. It came out at 18s. per point. The wires were not disfigurements; the decorations were laid or fixed over them, and might at any time be removed and the wires replaced with a minimum of cutting away of the structure. There were numerous questions raised by these useful, interesting, and suggestive papers to which—if time permitted—he (Major-General Webber) would have liked to refer.

(To be continued.)

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

[*Compiled expressly for this journal by* W. P. Thompson & Co., *Electrical Patent Agents*, 31, *High Holborn, London, W.C., to whom all inquiries should be addressed. Copies of any of the specifications may be obtained of* Messrs. W. P. Thompson & Co., *price, post free,* 8½*d. (in stamps.)*]

NEW PATENTS.—1896.

842. "Improvements in and connected with the manufacture of electric conductors." S. O. Cowper-Coles. Dated January 13th.

845. "Improvements in electrical appliances for automatically preventing railway collisions." D. Weisz and L. Epstein. Dated January 13th.

868. "Improvements in electric meters." C. Raab. Dated January 13th.

879. "Improvements in electric measuring instruments." Eversheb and Vignoles, Limited, and S. Eversheb. Dated January 13th.

880. "Improvements in electric heaters." G. Ewart and J. Vaughan-Sherrin. Dated January 13th.

888. "An improved secondary battery or accumulator." A. U. Alcock. Dated January 13th.

915. "Improvements in electric transformers for alternating currents." E. Scott. Dated January 14th.

916. "Safety non-sparking switch." E. Scott and E. J. Cochrane. Dated January 14th.

931. "Improvements in and relating to electrical devices for igniting gas." J. K. Semple. Dated January 14th.

964. "Improvements in telephonic apparatus." C. J. Schwarze. Dated January 14th.

976. "Improvements in or relating to electric arc lamps." H. J. Fisher. Dated January 14th.

977. "Improvements relating to the synchronising of alternating current motors for electrical power transmission." H. F. Parshall. Dated January 14th.

980. "Improvements in electrically regulating temperature in incubators, chicken rearers, conservatories, and the like, and apparatus therefor." A. W. Isenthal. Dated January 14th.

981. "Improvements in apparatus for printing telegraphic messages in type. G. M. Gibson. Dated January 14th.

986. "Improvements in the electro-deposition of metals." J. C. Graham. Dated January 14th.

1,006. "Improvements in electrical resistances." M. Zinner, jun. Dated January 15th.

1,054. "Improvements in voltaic batteries." D. G. Fitzgerald and W. C. Bersey. Dated January 15th.

1,068. "An improved electrical process for recovering metals from weak solutions, and for concentrating the electrolyte." J. C. Graham. Dated January 15th.

1,069. "Improvements in or connected with electrical condensers." C. Pollak. Dated January 15th.

1,123. "Improvement of "iron-clad" field-magnets." T. Pilkington. Dated January 16th.

1,144. "Improvements in electrodes for electrolytical purposes." W. Heraeus. Dated January 16th.

1,198. "Improvements in electric railways." J. W. Darley. Dated January 17th.

1,218. "Improvements relating to electric railways." G. Tolmie. Dated January 17th.

1,228. "Improvements in the manufacture of battery cells or vessels to contain acids or other chemicals." D. M. Hawes. Dated January 17th.

1,230. "Improvements in apparatus for measuring electricity." E. H. P. Humphreys. Dated January 17th.

1,237. "Improvements in and relating to electric incandescent lamps." C. J. P. Robertson. Dated January 17th.

1,238. "Improvements in the manufacture of electric batteries." P. A. Newton. (C. Willms, United States). Dated January 17th.

1,249. "Improvements in synchronising mechanisms for alternating generators." H. F. Parshall. Dated January 17th.

1,256. "Improvements in electric choking or impedance coils." W. J. Davy. Dated January 17th.

1,273. "Electrified spectacle frames (including all kinds of frames) whether folders, pince nez, or spectacles made on the same principle." A. V. Ford. Dated January 18th.

1,310. "Improvements in electrical igniting apparatus." H. Hirst and A. E. Angold. Dated January 18th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

1895.

148. "Improved methods and apparatus for measuring electrical currents." O. B. Shallenberger. Dated January 2nd. A pivoted conducting disc is caused to revolve under the action of two sets of inductor coils, one set of the coils being traversed by the current to be measured, and the other set being on the other side of the disc, but not exactly opposite to the first set, and traversed by currents different in phase to those which traverse the first set of coils. The number of revolutions of the disc, which is retarded by means of a magnetic field, is given by a counting mechanism. The meter is illustrated in various designs, and applied to various systems of alternating currents. 9 claims.

1,477. "Improvements in feeding mechanism for electric arc lamps." H. Bevis and G. Binswanger. Dated January 22nd. Two brackets are affixed to the ends of a guide rod in which brackets a right and left-handed screw is mounted. On this screw, and so as to slide on the guide rod, the carbon holders are mounted, so that by turning a milled head the feed may be regulated. 2 claims.

2,282. "Improvements in or relating to railway signalling and the like." W. S. Boult and C. R. Boult. Dated February 1st. An improvement on letters patent No. 17,041, of 1893. Refers to the reversing of the polarity of the magnetic field required to act on the divided armature or other receiving apparatus and applies the system described in the former patent to automatic block signalling.

2,308. "Improvements in apparatus for testing magnetic quality in iron." J. A. Ewing. Dated February 2nd. Consists of apparatus for testing samples of iron with respect to magnetic hysteresis, and consists of a carrier in which the sample is secured, and a magnet which induces magnetism in the sample so arranged that the magnetism of the sample is reversed by rotating either the carrier or the magnet. There is also an appliance for indicating the mechanical moment which is exerted between the sample and the magnet in consequence of the rotation. 3 claims.

2,343. "Improvements in or relating to electric incandescent lamps." A. E. Pope. Dated February 2nd. A means for attaching the lamp to the cap without plaster, consisting in fitting a flange on to the lamp bent into a partial screw form which tightens against two studs in the cap. The cap and flange may then be soldered together. 7 claims.

2,366. "Improvements in electro-dynamometers." Siemens Bros. and Co., and E. F. H. H. Lanckert. Dated February 2nd. Consists in a combination of two stationary coils and two suspended swinging coils controlled by torsion springs, so arranged that one portion of the current to be measured passes through one stationary coil to the supply conductor, while another portion after passing through the second stationary coil, both swinging coils and a resistance, also passes to the supply conductor, the resulting angular deflectors of the swinging coils being made to indicate the strength of the current. 2 claims.

2,570. "Improvements in chandeliers, electroliers, pendant hanging lamps, and brackets for gas, oil, or electric light." C. Meason and T. Ford. Dated February 6th. Consists in forming the brackets of, say, a three branched light in two hinged parts, so that each bracket may be drawn down. Suitable weights attached to chains riding over pulleys counterbalance the brackets. 1 claim.

2,604. "Improvements in electric arc lamps and their connections." R. E. B. Crompton. Dated February 6th. Means for attaching lamps to brackets, &c. A central tube is provided for the leads, having a nut on either end. These nuts grip two insulating bushes fitting on the central tube which in turn grip the lamp case. Instead of two nuts a flange may be formed on one end of the tube. 2 claims.

2,817. "Improvements in or connected with electrical conductors for heating purposes." H. Edmunds. Dated February 8th. Relates to a means for electrically heating in a liquid, and consists in coating the conductor with a substance allowing of the conductor of heat, but not of electricity, such as manganin covered with asbestos fibre. It is then sheathed with lead. 2 claims.

7,600. "Improvements in and relating to primary batteries." W. Rowbotham, H. Levetus, and S. I. Levetus. Dated April 16th. The cell is divided into two main compartments, one of which is again divided into three sub-compartments. The main partition has apertures near its upper and lower ends opening into the sub-compartment containing the carbon element. Drainage holes may be formed in the bottom of the contiguous sub-compartments containing the iron. A good circulation of the exciting fluid can thus be obtained and polarisation reduced. 5 claims.

17,495. "Electrical heating apparatus." V. I. Feeny. Dated September 19th. Obviates the use of a rheostat as commonly used with heaters. The body of the heater is formed of warp threads of asbestos and filling threads of asbestos having wire strands woven in them, these strands being continuous from end to end of the fabric, and provided with induction and eduction current conveyers. Various modifications are also described. 6 claims.

20,216. "Improvements in galvanic batteries." E. S. Boynton. Dated October 26th. The battery consists of an outer shell to contain the electrolyte and the cells. This cell has a perforated false bottom on which rest the bottomless cells containing the electrodes. Free circulation is thus obtained for the electrolyte. 4 claims.

20,306. "Improvements in electric power storage batteries or accumulators." J. Langelaan. Dated October 28th. The positive end plates in electric storage batteries have holes punched in them so that their surface, and consequently their capacity, is reduced to one half that of the whole plate. 1 claim.